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DEVELOPMENT OF A MOLAR VOLUME EQUATION SUITABLE FOR THE STRUCTURAL ANALYSIS OF HYDROCARBONS *

By M. L. BOYD † and D. S. MONTGOMERY †

SUMMARY

An equation has been developed which expresses the molar volume of 130 pure hydrocarbons prepared by API Project 42 in terms of five structural groups. This equation is intended for the structural analysis of hydrocarbons and has been discussed in this regard. The accuracy with which this equation expresses the molar volume of these compounds has been tabulated and compared with the values calculated from the equation of Kurtz and Sankin.

INTRODUCTION

DURING the course of developing a method of structural analysis for hydrocarbons, an equation was desired to express the molar volume of pure hydrocarbons in terms of five structural groups. The objective of this paper is to describe the development of an equation to express the molar volume of 130 hydrocarbons prepared by API Project 42 [15] in terms of these groups.

The molar volume of liquids has long been described in terms of a linear combination of atomic contributions on the basis of the early work of Kopp,[6] Le Bas,[10] and Traube.[18] During the past 25 years many empirical equations which express the molecular volume (or density) have been developed, notably by Calingaert,[1] Huggins,[5] Francis,[4] Smittenberg,[17] Kurtz and Sankin,[7, 8] and Rossini.[14] The majority of these equations [1, 4, 5, 17] express the molar volume of compounds containing only a limited number of structural groups and are concerned primarily either with the calculation of the molar volume for the members of a homologous series [1, 4, 5, 17] or with the effects of isomeric variation.[14] The basis of comparison by these authors has varied. Sometimes the molar volumes have been compared at the boiling points of the liquids, at absolute zero, and also at arbitrary fractions of the critical temperature, but for the most part the comparison has been made at room temperature under one atmosphere pressure. Special attention is drawn to the equation of Kurtz and Sankin,[8] since it was of the general type required for our purpose. Their equation expressed the molar volume as a linear function of three types of carbon groupings and the number of double bonds in the molecule.

The equation to be described here was designed specifically for use in a method of hydrocarbon structural analysis which consisted of the simultaneous solution of five equations, each of which expressed a property in terms of five structural carbon types. The molar volume equations developed by the authors mentioned above were not expressed in terms of a convenient set of parameters for this type of investigation; they were designed primarily to calculate the molar volume of known structures.

In the present investigation, it was desired to determine the structure from the simultaneous solution of five property equations. This method and its application to pure compounds have been reported elsewhere.[13] The form of the molar volume equation developed was found suitable when used in this manner. In addition, it was considered desirable both that the functional form adopted should be applicable to the molar refraction and that it should not be cumbersome mathematically, so as to simplify the solution of the five simultaneous equations.

Except where otherwise specified, the equation has been based on the molar volume, at 20° C and 1 atm, of hydrocarbons prepared by API Project 42.[15] This particular group of hydrocarbons was used because it was a convenient set of consistent data in the molecular weight range of interest to petroleum chemistry.

DEVELOPMENT OF THE MOLAR VOLUME EQUATION

Definition of Structural Types

A five-type carbon classification was chosen for this purpose. It is a modification of a four-type classification used by van Krevelen [9] in 1952 in a method of structural analysis for coal. The classification used by Kurtz and Sankin [8] was not found suitable when applied to the molar refraction, and hence was not used. The carbon linkages have therefore been divided into the following five types:

C_1 = number per molecule of CH_3, CH_2, CH, and C groups in linear and branched chains.

C_2 = number per molecule of CH_2 groups in saturated rings, including the case where the

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C C

hydrogen atoms may be replaced by branched or linear chains.

C_3 = number per molecule of CH groups which are junctions in fused saturated rings, as well as similarly situated groups where the hydrogen is replaced by linear or branched chains.

C_4 = number per molecule of CH groups in aromatic rings, including the case where the hydrogen may be replaced by branches or linear chains.

C_5 = number per molecule of $-\overset{|}{\underset{|}{C}}-$ groups which are junctions in fused aromatic rings, as well as junctions between saturated and aromatic rings.

Attention is drawn to the fact that this classification restricts this equation to certain specific classes of compounds. In the division of the carbon groups into the various types, care was taken that the equation $2C_1 + 2C_2 + C_3 + C_4 =$ total number of hydrogen atoms per molecule should always be satisfied. Of the compounds on the API 42 list, the polycyclic non-fused structures were not included in the above classification. A specific equation has been developed to cover this group.

Form of the Equation

Initially, on the basis of Kurtz and Sankin's work,[8] the following general form of the molar volume equation was assumed:

$$\text{M.V.} = v_1C_1 + v_2C_2 + v_3C_3 + v_4C_4 + v_5C_5 + \text{K} \quad (1)$$

It was found that there was no system of constant coefficients that was applicable to all five structural types. There were also indications that "K" was not constant. Hence, the following approach was adopted:

By definition, we have:

$$C_1 + C_2 + C_3 + C_4 + C_5 = \Sigma C \quad . \quad (2)$$

where ΣC is the total number of carbon atoms per molecule. By multiplication with K and division by ΣC, the following expression was obtained:

$$\frac{C_1K}{\Sigma C} + \frac{C_2K}{\Sigma C} + \frac{C_3K}{\Sigma C} + \frac{C_4K}{\Sigma C} + \frac{C_5K}{\Sigma C} = \text{K} \quad (3)$$

When K in equation (1) was replaced by the value in equation (3), the following equation was obtained:

$$\text{M.V.} = C_1\left(v_1 + \frac{\text{K}}{\Sigma C}\right) + C_2\left(v_2 + \frac{\text{K}}{\Sigma C}\right) + C_3\left(v_3 + \frac{\text{K}}{\Sigma C}\right) + C_4\left(v_4 + \frac{\text{K}}{\Sigma C}\right) + C_5\left(v_5 + \frac{\text{K}}{\Sigma C}\right) \quad (4)$$

It will subsequently be shown that the K's in each bracket are not identical; these have hence been designated K_1 to K_5 respectively.

DETERMINATION OF THE COEFFICIENTS

To determine the coefficients of C_1 to C_5 in equation (4), use was made of the fact that, for a molecule containing only one species of carbon groups, C_i, equation (4) assumed the following form, as C_i was equal to ΣC:

$$\text{M.V.} = v_iC_i + \text{K}_i \quad . \quad . \quad . \quad (5)$$

When the molar volume was plotted against C_i the resultant straight line had a slope of v_i and an intercept K_i. Consequently, v_i represented the contribution to the molar volume of a C_i group in the presence of an infinite number of C_i groups. As the molecular weight increased, the quantity $\frac{K_i}{\Sigma C}$ approached zero. The quantity $\frac{K_i}{\Sigma C}$ represents the effect of the molecular weight on the contribution of a C_i group to the molar volume.

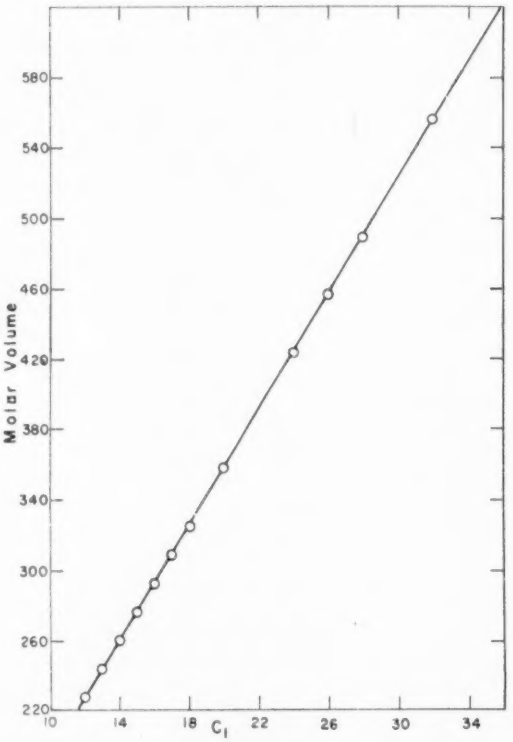

FIG 1

DETERMINATION OF v_1 AND K_1 FROM API 42 *n*-PARAFFINS

Certain groups (C_3 and C_5) do not exist alone in the molecule. The C_3 group always occurs with C_2 groups and C_5 with C_4. In this case a slightly different technique must be used. For example, if we consider a compound containing structural groups C_a and C_b, its molar volume can be expressed by the following equation:

$$\text{M.V.} = C_a\left(v_a + \frac{\text{K}_a}{\Sigma C}\right) + C_b\left(v_b + \frac{\text{K}_b}{\Sigma C}\right) \quad (6)$$

This can be rearranged as follows:

$$\frac{\text{M.V.} - C_a\left(v_a + \frac{K_a}{\Sigma C}\right)}{C_b} = v_b + \frac{K_b}{\Sigma C} \qquad (7)$$

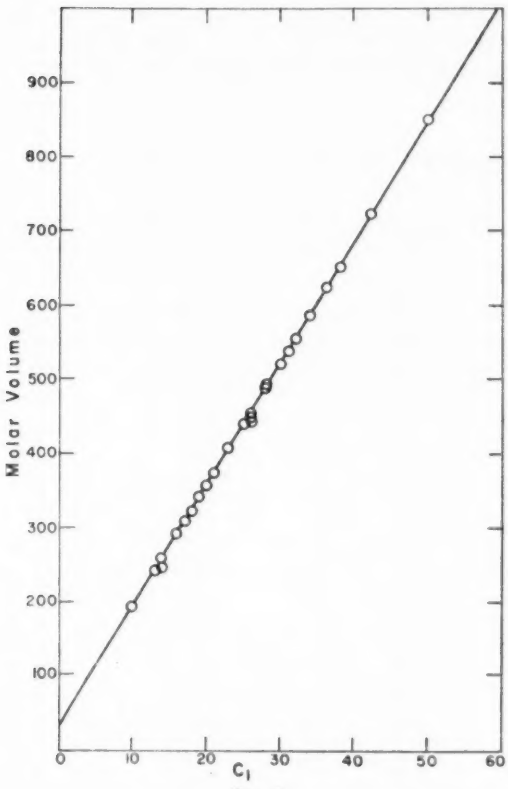

FIG 2

DETERMINATION OF v_1 AND K_1 FROM API 42 BRANCHED PARAFFINS

If we consider the case where v_a and K_a are known and we wish to determine v_b and K_b, it follows from equation (7) that when $\frac{\text{M.V.} - C_a\left(v_a + \frac{K_a}{\Sigma C}\right)}{C_b}$ is plotted against $1/\Sigma C$ the resultant straight line will have a slope of K_b and an intercept of v_b.

Determination of v_1 and K_1

The molar volumes for the thirteen normal paraffins on the list of API Project 42 [15] were plotted against the number of carbon atoms in the molecule (Fig 1). The equation of the resultant straight line was determined by the method of least squares and found to be as follows:

$$\text{M.V.} = 16{\cdot}38C_1 + 30{\cdot}61 \quad . \quad . \quad (8)$$

These values for v_1 and K_1, based on the *n*-paraffins, were used in equation (4), since it was considered desirable to have the C_1 coefficient represent the contribution to the molar volume of a C_1 group in a normal paraffin only. By excluding the effects of branching from the C_1 coefficient, it is possible to detect branching by examining the magnitude of C_2 obtained in the simultaneous solution of the five equations.

A certain amount of information about the effects of branching on the linear chain was obtained by studying the branched paraffins in a similar manner to that already given for the *n*-paraffins. The molar volume of 38 branched paraffins on the API 42 list was plotted against the number of carbon atoms in the molecule (Fig 2). By the method of least squares, the molar volume for this group could be expressed by the following equation:

$$\text{M.V.} = 16{\cdot}49C_1 + 26{\cdot}70 \quad . \quad . \quad (9)$$

If those paraffins containing one branch only are considered, their molar volume can be expressed by equation (10), thus:

$$\text{M.V.} = 16{\cdot}45C_1 + 28{\cdot}28 \quad . \quad . \quad (10)$$

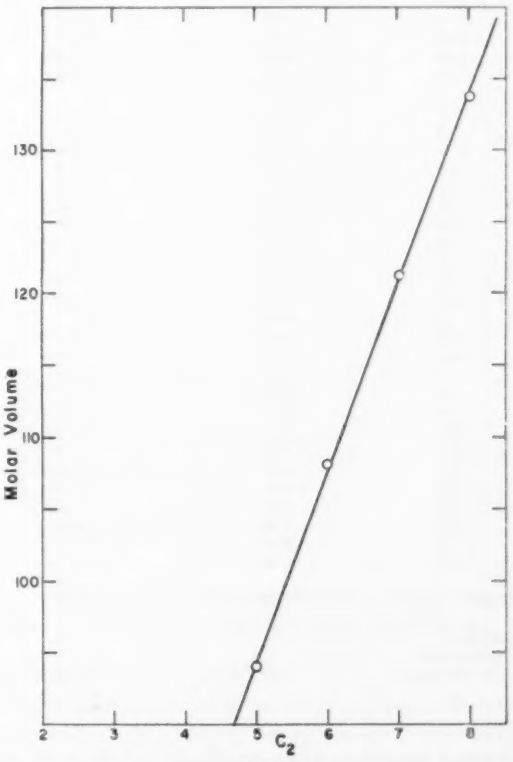

FIG 3

DETERMINATION OF v_2 AND K_2 FROM DATA OF WARD AND KURTZ

The molar volume was calculated for each of the API 42 branched paraffins by each of the two equations (8) and (9), to compare the use of the two equations for

branched paraffins and to investigate the "errors" resulting from using equation (8) to represent the branched paraffins. The results of these calculations are given in Table I.

Determination of v_2 and K_2

These quantities were calculated in a manner similar to that used for the calculation of v_1 and K_1 using the physical properties given by Ward and Kurtz [19] for *cyclo*pentane, *cyclo*hexane, *cyclo*heptane, and *cyclo*octane. This is expressed graphically in Fig 3. The molar volume of these compounds could be expressed by the following equation:

$$M.V. = 13{\cdot}20C_2 + 28{\cdot}48. \quad (11).$$

TABLE I

The Calculation of the Molar Volume of Branched Linear Paraffins by Equations (8) *and* (9)

API 42 Compound No.	$M.V._{\cdot calc\ 8} - M.V._{\cdot obs}$ ml.	$\frac{M.V._{\cdot calc\ 8} - M.V._{\cdot obs}}{M.V._{\cdot obs}} \times 100$, %	$M.V._{\cdot calc\ 9} - M.V._{\cdot obs}$ ml.	$\frac{M.V._{\cdot calc\ 9} - M.V._{\cdot obs}}{M.V._{\cdot obs}} \times 100$, %	No. of branches
549	+0·91	+0·47	−1·90	−0·98	1
546	+1·15	+0·47	−1·33	−0·55	1
512	+0·03	+0·012	−2·34	−0·90	1
556	+12·03	+4·85	+9·66	+3·90	7
545	+0·99	+0·34	−1·16	−0·40	1
557	+2·45	+0·76	+0·52	+0·16	2
500	+1·03	+0·30	−0·79	−0·23	1
510	+2·01	+0·56	+0·30	+0·084	1
511	+0·91	+0·26	−0·80	−0·22	1
554	+0·49	+0·13	−1·11	−0·30	1
163	+0·35	+0·086	−1·03	−0·25	1
25	+0·21	+0·048	−0·95	−0·22	1
1	+0·69	+0·15	−0·36	−0·079	1
2	+0·49	+0·11	−0·56	−0·12	1
3	+0·39	+0·086	−0·66	−0·14	1
4	+1·39	+0·30	+0·34	+0·075	1
22	+1·99	+0·44	+0·94	+0·21	2
23	+4·29	+0·95	+3·24	+0·72	3
27	+0·29	+0·064	−0·76	−0·17	1
51	+0·29	+0·064	−0·76	−0·17	1
53	+3·29	+0·73	+2·24	+0·49	2
55	+2·39	+0·53	+1·34	+0·30	2
67	−0·21	−0·046	−1·26	−0·28	3
109	+2·29	+0·50	+1·24	+0·27	1
5	+0·65	+0·13	−0·18	−0·037	1
63	+0·35	+0·072	−0·48	−0·098	1
184	−1·55	−0·32	−2·38	−0·48	7
6	+0·81	+0·16	+0·20	+0·038	1
8	+0·09	+0·017	−0·41	−0·076	1
7	+0·57	+0·103	+0·18	+0·032	1
191	−0·13	−0·023	−0·52	−0·094	1
107	+0·13	+0·022	−0·04	−0·0068	1
164	−0·37	−0·063	−0·54	−0·092	1
133	−0·41	−0·066	−0·36	−0·058	1
134	−0·39	−0·060	+0·02	+0·0031	1
182	−1·93	−0·27	−1·22	−0·17	8
58	−1·09	−0·13	+0·50	+0·059	1
59	−0·49	−0·058	+1·1	+0·13	2
Mean	+0·96	+0·31	−0·002	+0·0092	
Standard deviation of the mean	2·19	0·80	1·94	0·72	

EFFECTS OF SUBSTITUTION ON THE *cyclo*HEXANE RING

Having already calculated v_1, v_2, K_1, and K_2, it was now possible to study the effects, on the molar volume, of substitution in the saturated ring. The data of Ward and Kurtz [19] on methyl, dimethyl, trimethyl, and tetramethyl *cyclo*hexanes was used for this purpose. The molar volume for this group was calculated from the following equation:

$$M.V. = C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) + C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right). \quad (12)$$

The effect of a single side chain of varying length

was first considered. Calculated and observed molar volumes were compared for a series of substituted *cyclo*hexanes, each with a single side chain whose length varied from one to 20 carbon atoms. The difference between the observed and calculated molar volume was plotted *v.* the number of carbon atoms in the chain. The result is shown in Fig 4 and Table II.

TABLE II

The Effect of a Single Side Chain of Varying Length on the Molar Volume of Substituted cyclo*Hexanes*

$(M.V._{obs} - M.V._{calc})$ ml	No. of carbon atoms in normal side chain
3·026	1
2·149	2
2·291	3
1·933	4
1·831	5
1·463	8
1·389	10 (API 42 data)
1·382	20 ,, ,,

$\left[\dfrac{M.V._{obs} - C_2\left(13{\cdot}20 + \dfrac{28{\cdot}48}{\Sigma C}\right)}{C_3}\right]$ was plotted against $1/\Sigma C$. The result is shown in Fig 5. The straight line determined by the least squares method had a slope of 20·679 (K_3) and an intercept of 10·981 (v_3).

TABLE III

Poly Substituted cyclo*Hexanes*

Compound	$\left[\dfrac{M.V._{obs} - M.V._{calc}}{\text{No. of branches}}\right]$ ml
1,2-Dimethyl *cyclo*hexane .	0·89 (ortho substitution)
1,3- ,, ,, .	2·59 (meta substitution)
1,4- ,, ,, .	2·73 (para substitution)
1,2,3-Trimethyl *cyclo*hexane .	0·60
1,2,4- ,, ,, .	1·22
1,2,5- ,, ,, .	1·84
1,3,5- ,, ,, .	1·82
1,2,3,5-Tetramethyl *cyclo*hexane (*trans*)	−0·436
1,2,4,5-Tetramethyl *cyclo*hexane (*trans*)	−0·223
1,2,4,5-Tetramethyl *cyclo*hexane (*cis*)	−0·341

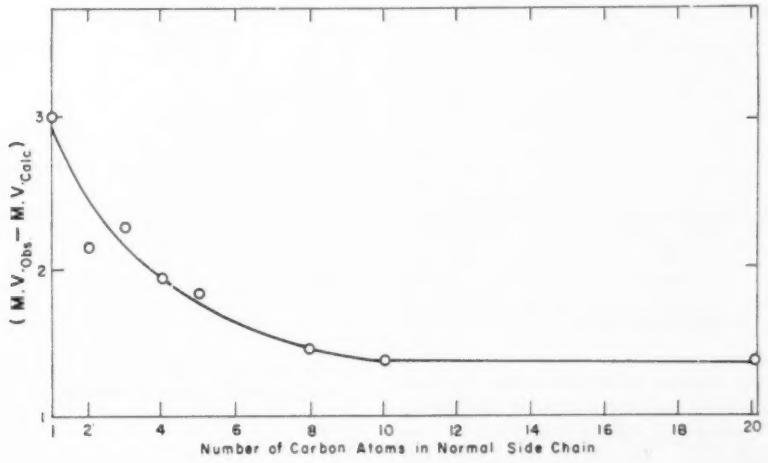

FIG 4

THE EFFECTS OF MONO SUBSTITUTION IN THE *cyclo*HEXANE RING

The dimethyl, trimethyl, and tetramethyl *cyclo*hexanes were similarly studied and the results are tabulated in Table III.

Determination of v_3 and K_3

Since no compounds existed containing C_3 groups only, the second technique for the determination of the coefficient, described on p. 346, was used. Compounds containing both C_2 and C_3 had to be used. The following compounds from the list of API Project 42 [15] were used: bi*cyclo*octane 543, decahydronaphthalene 569 and 570, perhydrofluorene 561, perhydropyrene 578, and perhydrochrysene 575.

Determination of v_4 and K_4

To determine v_4 and K_4 in an analogous manner to that used for C_1 and C_2, it was necessary to have data for three or more compounds containing varying numbers of C_4 groups only. Some difficulty was experienced in obtaining suitable data. The following compounds were used: benzene (properties from Egloff [3]), *cyclo*-octatetraene (properties by Eccleston [2]), and *cyclo*pentadiene (Ward and Kurtz [19]).

A word of explanation about the use of the *cyclo*-

pentadiene is required. Since it contained one C_2 group, its use here is, strictly speaking, not justified in view of the presence of two different types of

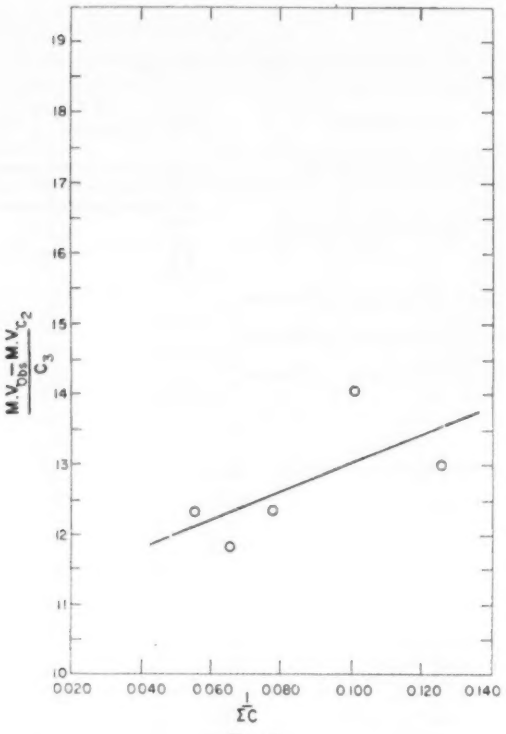

FIG 5

DETERMINATION OF v_3 AND K_3 FROM API 42 DATA FOR FUSED NAPHTHENES

groups C_2 and C_4. Owing to the scarcity of data, however, the observed molar volume of the *cyclo*-pentadiene was taken and the contribution of one CH_2 group was deducted. This treatment ignores the interaction between C_2 and C_4 groups in a single ring. This amounted to considering a hypothetical compound C_4H_4 having four C_4 groups and a molar volume of $\left[\text{M.V.}_{\text{-cyclopentadiene}} - 1\left(13{\cdot}20 + \frac{28{\cdot}48}{5}\right)\right]$.

Fig 6 is the graph of molar volume v. number of C_4's for the three compounds. The least squares equation of the resultant straight line through these compounds was found to be:

$$\text{M.V.} = 12{\cdot}406C_4 + 14{\cdot}042 \quad . \quad . \quad (13)$$

Determination of v_5 and K_5

Since compounds normally do not exist containing only C_5 groups, compounds containing C_4 and C_5 were used and v_5 and K_5 were determined by the same method as was used for v_3 and K_3. The literature revealed a scarcity of suitable liquid state data for fused-ring aromatic compounds. This shortage of data was overcome in the following manner. Ubbelohde [11, 12] has measured the volume changes on melting for a number of fused-ring aromatic compounds. His paper contained, for each compound, a graph in which molar volume was plotted against temperature. The molar volume of the liquid at 20° C was obtained by extrapolating the liquid portion of the curve to 20° C, and the solid volume was read directly off the graph. In this manner the shrinkage in volume at 20° C, [M.V. (l) − M.V. (s)], was obtained for dimethyl naphthalene, phenanthrene, anthracene, and chrysene. [M.V. (l) − M.V. (s)] was plotted v. the ratio C_5/C_4, the degree of condensation. The result is shown in Fig 7. By means of this linear relationship, the solid state molar volume data of van Krevelen [16] for fused-ring aromatic compounds was " converted " to the liquid state at 20° C. Using data obtained in this manner

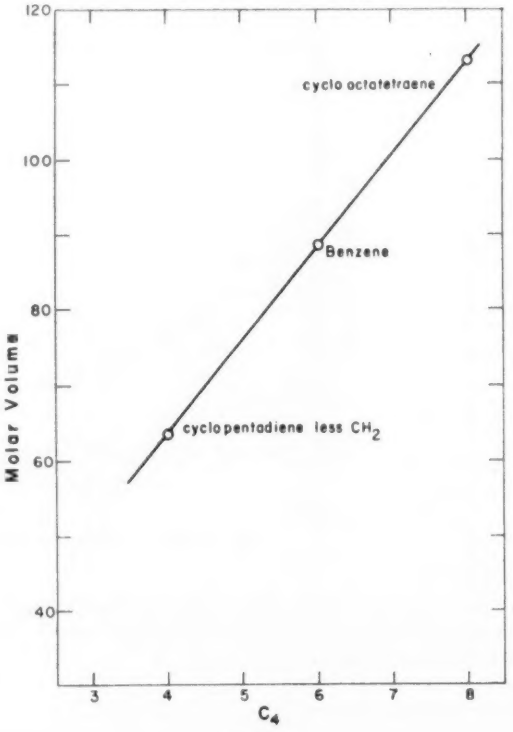

FIG 6

DETERMINATION OF v_4 AND K_4

for anthracene, chrysene, and phenanthrene (Ubbelohde), and for dibenzanthracene, chrysene, pyrene, and coronene (van Krevelen's data converted to the liquid state), $[\text{M.V.}_{\text{obs}} - \text{M.V.}_{C_4}]/C_5$ was plotted v. $1/\Sigma C$. The result is shown in Fig 8. From this

graph v_5 was determined to be 5·124 and K_5 to be −5·238.

It will be noticed, in Fig 8, that the scatter about the least squares line is quite appreciable in comparison with the data used for the determination of

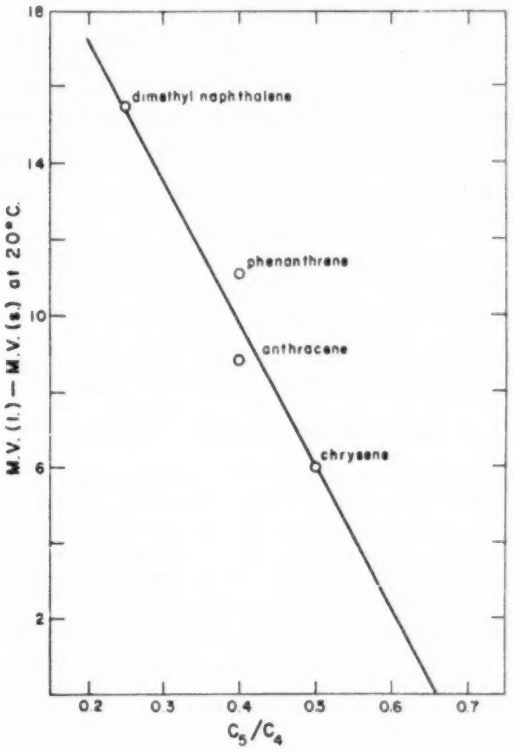

FIG 7

THE DIFFERENCE IN MOLAR VOLUME BETWEEN LIQUID AND SOLID STATES, AS A FUNCTION OF THE DEGREE OF CONDENSATION FOR FUSED-RING AROMATIC COMPOUNDS

the other coefficients in the equation. For this reason, these compounds were investigated further in the following manner. The molar volume was calculated for these compounds using the following equation:

$$\text{M.V.} = C_4\left(12{\cdot}406 + \frac{14{\cdot}042}{\Sigma C}\right) + C_5\left(5{\cdot}124 - \frac{5{\cdot}238}{\Sigma C}\right). \quad (14)$$

and also using the equation of Kurtz and Sankin.[8] The mean percentage error in the calculated values was determined to be −0·02 per cent for equation (14), with a standard deviation of 2·34 per cent, and for Kurtz and Sankin's equation was +4·05 per cent with a standard deviation of 3·01 per cent. The order of accuracy achieved using these values of v_5 and K_5 was found to be adequate for this approximate method of analysis.

At this point, by substituting into equation (4) the values for the v's and K's just determined, the following molar volume equation was obtained:

$$\text{M.V. at } 20^\circ\text{ C and 1 atm} = C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) + C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right) + C_3\left(10{\cdot}981 + \frac{20{\cdot}679}{\Sigma C}\right) + C_4\left(12{\cdot}406 + \frac{14{\cdot}042}{\Sigma C}\right) + C_5\left(5{\cdot}124 - \frac{5{\cdot}238}{\Sigma C}\right) \quad (15)$$

Equation (15) was used to calculate the molar volume for the appropriate classes of compounds on the API 42 list,[15] and to compare the results with the experimental values. The percentage difference between calculated and observed molar volumes was calculated in each case. The results of this series of calculations revealed that the error was particularly high (about 2 per cent) for two classes, namely, the monocyclic aromatics and the fused-ring aromatics.

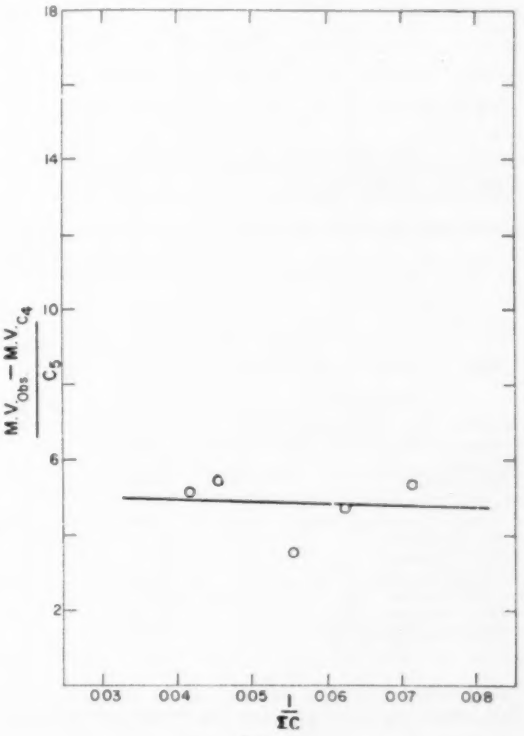

FIG 8

DETERMINATION OF v_5 AND K_5

To correct these errors, a study of the interactions between various types of structural groups was made.

Interaction between C_1 and C_4 in Monocyclic Aromatics

When equation (15) was used to calculate the molar volume of the API 42 monocyclic aromatics, the mean

percentage error between observed and calculated values of the molar volume was found to be 2·25 per cent. In order to reduce this error, a study was made of the molar volume of a series of *n*-alkyl benzenes whose properties have been determined by Ward and Kurtz.[19] It was found possible to express the difference between calculated and observed molar volume

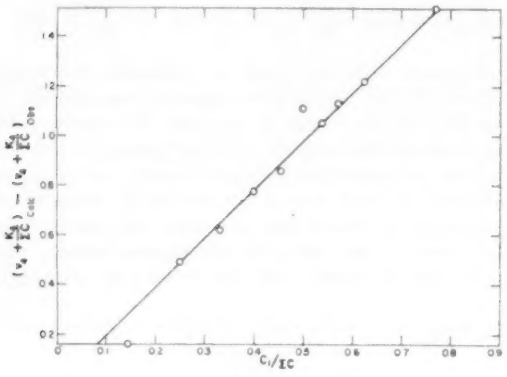

FIG 9

DETERMINATION OF THE INTERACTION EFFECT BETWEEN C_1 AND C_4

as a linear function of the number of C_1 groups in the molecule in the following manner. For each compound, two quantities were calculated: $\left(v_4+\frac{K_4}{\Sigma C}\right)_{calc}$, *i.e.* the volume of a C_4 group as calculated by equation (15); and $\left(v_4+\frac{K_4}{\Sigma C}\right)_{obs}$, *i.e.* the actual volume of a C_4 group. The latter quantity is equal to

$$\left[\text{M.V.}_{obs}-C_1\left(16{\cdot}38+\frac{30{\cdot}61}{\Sigma C}\right)\right]\Big/C_4.$$

These data are shown in Table IV.

They have also been expressed graphically in Fig 9. This figure indicates that a linear relationship existed between $\left[\left(v_4+\frac{K_4}{\Sigma C}\right)_{calc}-\left(v_4+\frac{K_4}{\Sigma C}\right)_{obs}\right]$ and $C_1/\Sigma C$. The equation of this line was determined to be:

$$\left(v_4+\frac{K_4}{\Sigma C}\right)_{calc}-\left(v_4+\frac{K_4}{\Sigma C}\right)_{obs}=1{\cdot}96\,\frac{C_1}{\Sigma C} \quad (16)$$

This can be rearranged as follows:

$$\left(v_4+\frac{K_4}{\Sigma C}\right)_{obs}=\left(v_4+\frac{K_4}{\Sigma C}\right)_{calc}-1{\cdot}96\,\frac{C_1}{\Sigma C} \quad (17)$$

This equation indicated that the volume of a C_4 group as calculated by equation (15) should be reduced by an amount equal to $1{\cdot}96\,\frac{C_1}{\Sigma C}$. Equation (17) was hence incorporated as a correction factor in equation (15), which then became:

$$\begin{aligned}\text{M.V.}=\;&C_1\left(16{\cdot}38+\frac{30{\cdot}61}{\Sigma C}\right)+C_2\left(13{\cdot}20+\frac{28{\cdot}48}{\Sigma C}\right)\\&+C_3\left(10{\cdot}981+\frac{20{\cdot}679}{\Sigma C}\right)\\&+C_4\left(12{\cdot}406+\frac{14{\cdot}042}{\Sigma C}-1{\cdot}96\,\frac{C_1}{\Sigma C}\right)\\&+C_5\left(5{\cdot}124-\frac{5{\cdot}238}{\Sigma C}\right). \quad (18)\end{aligned}$$

It should be noted that this "correction factor" is of such a form that it becomes zero when $C_1 = 0$ and also is eliminated when $C_4 = 0$, both of which are desirable characteristics from a structural analysis viewpoint. The normal alkyl benzenes used to calculate this factor were chosen in preference to the API 42 monocyclic aromatics, since it was considered desirable to have normal side chains only and thus eliminate any possible additional effects of branching.

TABLE IV

Determination of the Interaction Effect between C_1 and C_4 in Monocyclic Aromatics

Compound	$\left(v_4+\frac{K_4}{\Sigma C}\right)_{calc}$	$\left(v_4+\frac{K_4}{\Sigma C}\right)_{obs}$	$C_1/\Sigma C$	$\left[\left(v_4+\frac{K_4}{\Sigma C}\right)_{calc}-\left(v_4+\frac{K_4}{\Sigma C}\right)_{obs}\right]$
Benzene	14·75	14·81	0	−0·06
Toluene	14·41	14·25	0·14	0·16
Ethyl benzene	14·16	13·67	0·25	0·49
n-Propyl benzene	13·97	13·35	0·33	0·62
n-Butyl	13·81	13·03	0·40	0·78
n-Amyl benzene	13·68	12·82	0·46	0·86
n-Hexyl benzene	13·58	12·47	0·50	1·11
n-Heptyl benzene	13·48	12·43	0·54	1·05
n-Octyl benzene	13·41	12·28	0·57	1·13
n-Decyl benzene (API)	13·28	12·06	0·62	1·22
1-Phenyleicosane (API)	12·95	11·44	0·77	1·51

Interaction Effects of C_2 in Fused-ring Aromatics

When calculating the molar volume for the API 42 fused-ring aromatics, using equation (18) (*i.e.* making use of the correction term added in the previous section), it was noticed that, for fused-ring compounds containing C_2 groups, the calculated molar volume was, in all cases, too small (mean error, 2·8 per cent).

In a similar manner to the method used to investigate the interaction of C_1 in monocyclic aromatics, the effect of the presence of C_2 groups in fused-ring aromatics was studied. It was desired to express the difference between observed and calculated molar volume as a linear function of the number of C_2 groups in the molecule. By the very nature of the structure of such compounds it was impossible to obtain a series of compounds whose only variable was C_2. Consequently, this effect was based entirely on API 42 fused-ring aromatics. Initially this difference between calculated and observed molar volume was expressed in terms of the C_5 group and a relationship was sought between $\left[\left(v_5+\frac{K_5}{\Sigma C}\right)_{obs}-\left(v_5+\frac{K_5}{\Sigma C}\right)_{calc}\right]$ and $C_2/\Sigma C$. No relation appeared obvious. However, a linear relationship was found between $\left[\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{obs}-\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{calc}\right]$ and $C_2/\Sigma C$. The data upon which this relationship is based are given in Table V and graphically expressed in Fig 10. The straight line shown in Fig 10 has the following equation, as determined by the method of least squares:

$$\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{obs}-\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{calc}=10{\cdot}127\frac{C_2}{\Sigma C}-0{\cdot}003 \quad . \quad (19)$$

The intercept (−0·003) in equation (19) was so close to zero that it was actually considered so, since, as has already been mentioned, it is essential that this "correction factor" become zero when C_2 is equal to zero. Equation (19) can be rearranged as follows:

$$\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{obs}=\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{calc}+10{\cdot}13\frac{C_2}{\Sigma C} \quad . \quad (20)$$

As in the case of C_1 and the monocyclic aromatics, equation (20) has been used to "correct" equation (18). The correction amounted to increasing the volume of each C_4 group by an amount equal to $10{\cdot}13\frac{C_2}{\Sigma C}$. It should be pointed out that there is one type of fused-ring aromatic to which this correction factor is not applicable, *i.e.* the case where $C_4=0$ but $C_5\neq 0$. This case will have to be dealt with separately.

The complete molar volume equation, incorporat-

TABLE V

Determination of the Interaction Effect between C_2 and C_4 in API 42 Fused-Ring Aromatics

API 42 Compound No.	$\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{calc}$	$\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{obs}$	$C_2/\Sigma C$	$\left[\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{obs}-\left(v_4+\frac{K_4}{\Sigma C}-1{\cdot}96\frac{C_1}{\Sigma C}\right)_{calc}\right]$
576	13·28	15·00	0·19	1·72
574	13·19	18·85	0·56	5·67
16	11·71	13·12	0·12	1·41
188	11·79	13·54	0·16	1·75
165	12·34	16·32	0·38	3·98
179	12·34	13·64	0·15	1·30
189	11·84	13·03	0·07	1·19
173	11·53	12·38	0·13	0·85

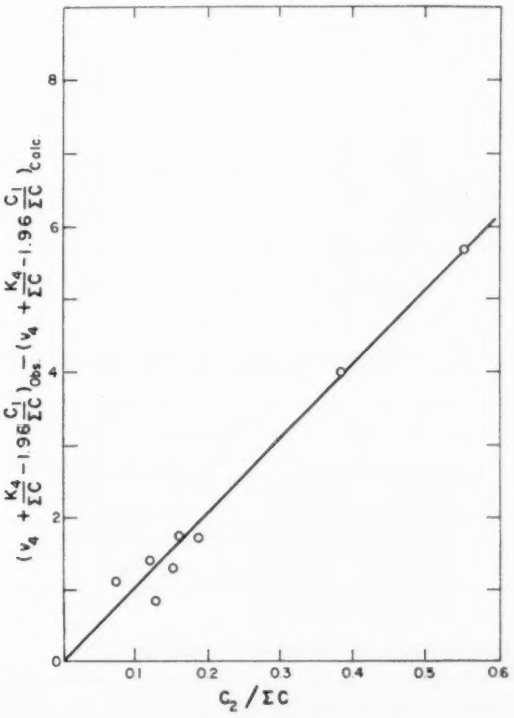

FIG 10

DETERMINATION OF THE INTERACTION EFFECTS OF C_2 IN FUSED-RING AROMATICS

TABLE VI

Calculation of Molar Volume by Equation (21) of the API 42 Hydrocarbons

API 42 Cpd No.	M.V.calc ml	M.V.obs ml	M.V.calc − M.V.obs ml	$\frac{\text{M.V.calc} - \text{M.V.obs}}{\text{M.V.obs}} \times 100$ %
n-Paraffins				
528	227·17	227·5	−0·3	−0·14
529	243·55	243·8	−0·2	−0·10
531	259·93	260·0	−0·1	−0·03
533	276·31	276·4	−0·1	−0·03
534	292·69	292·6	+0·1	+0·03
535	309·07	309·1	−0·03	−0·01
537	325·45	325·1	+0·35	+0·11
540	358·21	358·1	+0·11	+0·03
541	423·73	423·9	−0·2	−0·04
106	456·49	456·1	+0·4	+0·09
176	489·25	489·3	−0·05	−0·01
197	544·77	555·3	−0·5	−0·10
190	620·29	620·4	−0·1	−0·02
Branched Paraffins				
549	194·41	193·5	+0·91	+0·47
546	243·55	242·4	+1·15	+0·47
512	259·93	259·9	+0·03	+0·012
556	259·93	247·9	+12·03	+4·85
545	292·69	291·7	+0·99	+0·34
557	325·45	323·0	+2·45	+0·76
500	341·83	340·8	+1·03	+0·30
510	358·21	356·2	+2·01	+0·56
511	358·21	357·3	+0·91	+0·26
554	374·59	374·1	+0·49	+0·13
163	407·35	407·0	+0·35	+0·086
25	440·11	439·9	+0·21	+0·048
1	456·49	455·8	+0·69	+0·15
2	456·49	456·0	+0·49	+0·11
3	456·49	456·1	+0·39	+0·086
4	456·49	455·1	+1·39	+0·30
22	456·49	454·5	+1·99	+0·44
23	456·49	452·2	+4·29	+0·95
27	456·49	456·2	+0·29	+0·064
51	456·49	456·2	+0·29	+0·064
53	456·49	453·2	+3·29	+0·73
55	456·49	454·1	+2·39	+0·53
67	456·49	456·7	−0·21	−0·046
109	456·49	454·2	+2·29	+0·50
5	489·25	488·6	+0·65	+0·13
63	489·25	488·9	+0·35	+0·072
184	489·25	490·8	−1·55	−0·32
6	522·01	521·2	+0·81	+0·16
8	538·39	538·3	+0·09	+0·017
7	554·77	554·2	+0·57	+0·103
191	554·77	554·9	−0·13	−0·023
107	587·53	587·4	+0·13	+0·022
164	587·53	587·9	−0·37	−0·063
133	620·29	620·7	−0·41	−0·066
134	653·05	653·3	−0·39	−0·060
182	718·57	720·5	−1·93	−0·27
58	849·61	850·7	−1·09	−0·13
59	849·61	850·1	−0·49	−0·058
Monocyclic Saturates				
539	239·94	241·4	−1·46	−0·61
514	239·94	238·5	+1·44	+0·60
573	259·7	259·5	+0·2	+0·08
572	272·81	274·2	−1·39	−0·51
542	325·36	323·9	+1·46	+0·45
504	322·07	320·4	+1·67	+0·52
509	387·71	386·8	+0·91	+0·24
110	423·7	423·0	+0·70	+0·16
88	420·44	421·1	−0·66	−0·16
117	440·24	439·9	+0·34	+0·08
64	440·24	437·9	+2·34	+0·53
100	456·92	458·3	−1·38	−0·32
102	456·92	455·8	+1·12	+0·26
75	456·92	455·0	+1·92	+0·44
104	456·92	455·2	+1·72	+0·39
76	456·92	455·7	+1·22	+0·28
77	456·92	455·9	+1·02	+0·23
78	456·92	455·8	+1·12	+0·26
153	456·97	457·7	−0·73	−0·17
162	456·97	455·8	+1·17	+0·27
74	456·47	455·7	+0·77	+0·17
60	453·21	452·3	+0·91	+0·20
91	469·36	470·5	−1·14	−0·24
180	489·36	492·5	−3·14	−0·64
69	518·97	518·2	+0·77	+0·15
136	584·31	584·0	+0·31	+0·05
138	649·86	649·6	+0·26	+0·04
Fused-ring Saturates				
527	268·66	264·7	+4·0	+1·51
125	400·75	400·0	+0·75	+0·19
141	400·75	397·8	+2·95	+0·74
544	336·60	335·3	+1·30	+0·39
175	402·40	401·6	+0·80	+0·20
155	402·42	393·1	+9·32	+2·37

TABLE VI (*contd.*)

Calculation of Molar Volume by Equation (21) of the API 42 Hydrocarbons

API 42 Cpd No.	M.V.calc ml	M.V.obs ml	M.V.calc − M.V.obs ml	$\frac{\text{M.V.calc} - \text{M.V.obs}}{\text{M.V.obs}} \times 100$ %
Fused-ring Saturates				
166	382·66	381·7	+1·00	+0·26
62	500·96	497·6	+3·36	+0·68
177	456·64	450·2	+6·44	+1·43
193	423·73	418·4	+5·33	+1·28
108	405·66	405·0	+0·66	+0·16
196	369·42	364·3	+5·12	+1·40
178	425·357	422·8	+2·56	+0·60
543	127·69	126·6	+1·09	+0·86
569–570	154·482	156·5	−2·0	−1·29
561	188·81	187·9	+0·91	+0·48
578	223·44	220·8	+2·64	+1·20
575	250·16	251·4	−1·24	−0·49
Monocyclic Aromatics				
538	222·26	222·2	+0·062	+0·02
513	222·26	222·0	+0·26	+0·12
571	256·0	255·3	+0·70	+0·27
502	304·70	305·0	−0·30	−0·10
87	403·3	402·7	+0·60	+0·15
10	403·3	403·1	+0·20	+0·05
99	419·77	419·8	−0·03	−0·01
101	419·77	419·5	+0·27	+0·06
79	419·77	419·6	+0·17	+0·04
103	419·77	419·6	+0·17	+0·04
80	419·77	419·5	+0·27	+0·06
81	419·77	420·2	−0·43	−0·10
82	419·77	420·4	−0·63	−0·15
152	419·77	420·4	−0·63	−0·15
161	419·77	420·4	−0·63	−0·15
9	436·20	436·9	−0·70	−0·16
54	452·6	450·0	+2·60	+0·58
168	469·04	467·3	+1·74	+0·37
68	501·84	502·3	−0·46	−0·09
135	567·49	568·3	−0·81	−0·14
137	632·09	633·9	−0·81	−0·13
Fused-ring Aromatics				
567–568	136·5	140·3	−3·8	−2·70
576	187·48	186·2	+1·28	+0·69
526	219·15	222·5	−3·35	−1·50
574	229·02	229·1	−0·08	−0·03
559	302·37	304·4	−2·0	−0·66
16	386·23	387·0	−0·77	−0·20
188	384·90	385·4	−0·50	−0·13
174	368·22	370·3	−2·1	−0·57
165	359·13	359·3	−0·17	−0·05
124	350·79	354·9	−4·1	−1·16
179	338·39	336·3	+2·1	+0·62
189	386·46	389·1	−2·60	−0·67
173	482·44	480·6	+1·80	+0·37

ing the two interaction terms, assumes the following form:

$$\text{M.V. at } 20^\circ\text{ C and 1 atm} = C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) + C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right) + C_3\left(10{\cdot}981 + \frac{20{\cdot}679}{\Sigma C}\right) + C_4\left(12{\cdot}406 + \frac{14{\cdot}042}{\Sigma C} - 1{\cdot}96\,\frac{C_1}{\Sigma C} + 10{\cdot}13\,\frac{C_2}{\Sigma C}\right) + C_5\left(5{\cdot}124 - \frac{5{\cdot}238}{\Sigma C}\right) . \quad (21)$$

Accuracy of Proposed Molar Volume Equation

The molar volume was calculated according to equation (21) for 130 hydrocarbons prepared by API Project 42.[15] The results are given in Table VI. The accuracy with which this equation predicted the molar volume of these compounds is tabulated in Table VII. For purposes of comparison, the molar volume for these compounds was also calculated according to the equation of Kurtz and Sankin,[8] and the accuracy of this equation is also given.

Polycyclic Non-fused Hydrocarbons

On p. 346 it was stated that the five structural types chosen for the purpose of our structural analysis did not include the ring carbon atoms which form the point of attachment in polycyclic non-fused hydrocarbons. It had originally been intended that this five-carbon classification should cover all types of hydrocarbons on the API 42 list. However, as will be shown, this was not possible. In a compound of the type R–$(C_1)_n$–R, where R represents a ring, if all the carbons in the ring were C_2 or C_4 groups, as the case might be, then the hydrogen balance equation $2C_1 + 2C_2 + C_3 + C_4$ = total number of hydrogen atoms would not be satisfied (since one hydrogen atom would be lacking for each ring). Since it was essential that this hydrogen balance equation be satisfied, the "junction" (CH– or C– in the above formula) carbon atoms in these compounds could not be considered as C_2 (or C_4) groups. However, it was evident from spatial considerations that these so-called "isolated" ring junctions could not be considered identical to the fused-ring junctions already studied. Consequently, in order to study the polycyclic non-fused hydrocarbons, two additional structural groups have been defined as follows:

C_6 = number per molecule of CH groups in a saturated ring which are the "junctions" between non-fused rings, or, in other words, C_6 represents CH_2 groups in saturated rings where one hydrogen has been replaced by a ring R or a chain terminating in a ring, $-(C_1)_nR$.

C_7 = number per molecule of $-\overset{|}{\underset{|}{C}}-$ groups in aromatic rings which constitute "junctions" between non-fused rings, *i.e.* C_7 = the number of CH groups in aromatic rings where the hydrogen is replaced by a ring R or a chain terminating in a ring, $-(C_1)_nR$.

The molar volume equation could then be extended by adding two terms, namely, $C_6\left(v_6 + \frac{K_6}{\Sigma C}\right)$ and $C_7\left(v_7 + \frac{K_7}{\Sigma C}\right)$.

Determination of v_6 and K_6

These coefficients were determined by the method described for v_3 and K_3. However, in this case data were lacking for a sufficient number of suitable compounds containing C_2 and C_6 groups only, and, consequently, v_6 and K_6 had to be based on compounds containing C_1, C_2, and C_6 groups. Twelve non-fused naphthenes from the API 42 list were used. For each of these compounds, the value of

$$\left[\text{M.V.}_{\text{obs}} - C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) - C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right)\right] \Big/ C_6$$

was calculated. This quantity was plotted *v.* $1/\Sigma C$. These data are tabulated in Table VIII and represented graphically in Fig 11.

TABLE VII

Accuracy of the Authors' Molar Volume Equation and the Kurtz and Sankin Equation Applied to API 42 Hydrocarbons

Class of compound	No. in class	Authors' equation		Kurtz and Sankin equation	
		Mean value of $\frac{\text{M.V.}_{\text{calc}} - \text{M.V.}_{\text{obs}}}{\text{M.V.}_{\text{obs}}} \times 100$	Standard deviation from the mean	Mean value of $\frac{\text{M.V.}_{\text{calc}} - \text{M.V.}_{\text{obs}}}{\text{M.V.}_{\text{obs}}} \times 100$	Standard deviation from the mean
n-Paraffins	13	−0·02	0·07	−0·40	0·08
br-Paraffins	38	+0·31	0·80	−0·11	0·82
Monocyclic saturates	27	+0·10	0·33	−0·11	0·35
Fused-ring saturates	10	+0·66	0·80	+0·06	0·82
Monocyclic aromatics	21	+0·03	0·19	−0·57	0·23
Fused-ring aromatics	13	−0·46	0·89	−0·36	0·49

TABLE VIII

Data for the Determination of v_6 and K_6

API 42 Cpd No.	$\frac{\left[\text{M.V.}_{\text{obs}} - C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) - C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right)\right]}{C_6}$	$1/\Sigma C$
551	15·71	0·1
548	15·20	0·067
580	13·49	0·085
520	16·51	0·071
564	12·42	0·062
505	13·53	0·053
507	12·87	0·053
553	13·91	0·045
19	15·25	0·040
11	13·46	0·038
199	13·53	0·037
172	15·3	0·036

The least squares equation of the straight line in Fig 11 was found to be:

$$\frac{\text{M.V.}_{\text{obs}} - C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) - C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right)}{C_6} = 17{\cdot}691 \cdot \frac{1}{\Sigma C} + 13{\cdot}241 \quad . \quad (22)$$

i.e. $v_6 = 13{\cdot}24$ and $K_6 = 17{\cdot}691$.

Rearranging equation (22), the molar volume of

non-fused naphthenes could be represented by the following equation:

$$\text{M.V.} = C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) + C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right) + C_6\left(13{\cdot}24 + \frac{17{\cdot}69}{\Sigma C}\right) \quad . \quad (23)$$

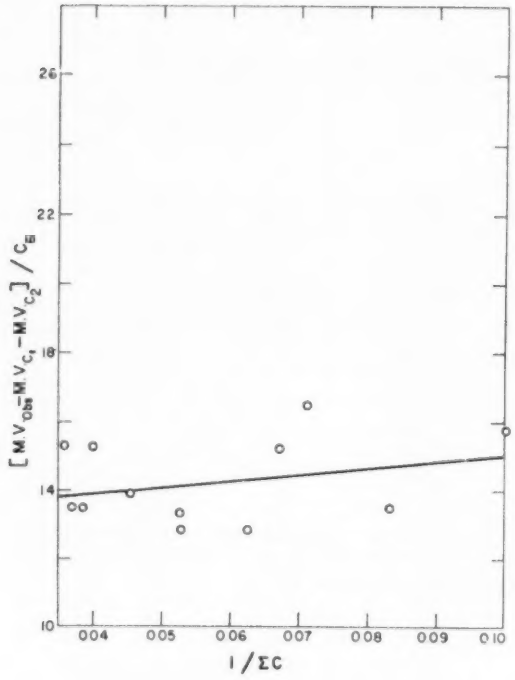

FIG 11

DETERMINATION OF v_6 AND K_6

Equation (23) was then used to calculate the molar volume of 23 non-fused naphthenes on the API 42 list. The mean value of the quantity

$$\frac{\text{M.V.}_{\text{calc}} - \text{M.V.}_{\text{obs}}}{\text{M.V.}_{\text{obs}}} \times 100$$

was determined to be −0·06 and the standard deviation of the mean was 0·96.

Determination of v_7 and K_7

At the outset of the investigation of non-fused polycyclic aromatics, it was assumed that the two interaction terms in C_1 and C_2 which had been added as "corrections" to the C_4 term in equation (21) would be valid for non-fused polycyclic aromatics. If this were so, it would have led to a single molar volume equation applicable to both fused and non-fused hydrocarbons. On the basis of this assumption, the following quantity (the volume increment of a C_7 group)

$$\left[\text{M.V.}_{\text{obs}} - C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) - C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right) - C_4\left(12{\cdot}406 + \frac{14{\cdot}042}{\Sigma C} - 1{\cdot}96\,\frac{C_1}{\Sigma C} + 10{\cdot}13\,\frac{C_2}{\Sigma C}\right) - C_6\left(13{\cdot}24 + \frac{17{\cdot}69}{\Sigma C}\right)\right] \Big/ C_7$$

was calculated for each of fourteen non-fused aromatics on the API 42 list. From the results it became apparent immediately that the compounds were divided into two groups, namely, those containing only aromatic rings and those containing both aromatic and saturated rings. The C_7 increment for the former was always positive and for the latter case always negative. From the magnitude of the coefficients it was determined that this difference was largely due to the C_2 interaction term which would be included in the calculation for compounds containing both aromatic and saturated non-fused rings but which would be zero for compounds containing only aromatic rings. Consequently, the C_7 increment was again calculated for the same fourteen compounds but omitting the C_2 interaction term on C_4; these results are tabulated in Table IX.

TABLE IX

Data for the Determination of v_7 and K_7

API Compound No.	$\left[\frac{\text{M.V.}_{\text{obs}} - \text{M.V.}_{C_1} - \text{M.V.}_{C_2} - \text{M.V.}_{C_4} - \text{M.V.}_{C_6}}{C_7}\right]$	$1/\Sigma C$
521	9·85	0·071
522	8·52	0·071
517	7·85	0·071
128	7·67	0·040
130	9·54	0·040
126	6·64	0·040
519	7·94	0·071
516	6·94	0·071
503	7·77	0·053
18	8·50	0·040
89	5·41	0·040
12	8·48	0·038
116	8·92	0·038
171	6·47	0·036

$\text{M.V.}_{C_7}/C7$ was then plotted *v.* $1/\Sigma C$. The graph of this plot is shown in Fig 12. The least squares straight line through these points was calculated and found to be:

$$\left[\frac{\text{M.V.}_{\text{obs}} - \text{M.V.}_{C_1} - \text{M.V.}_{C_2} - \text{M.V.}_{C_4} - \text{M.V.}_{C_6}}{C_7}\right] = 16{\cdot}533\,\frac{1}{\Sigma C} + 7{\cdot}0389 \quad . \quad (24)$$

Rearranging this, the molar volume equation for these compounds then became:

$$\text{M.V.} = C_1\left(16{\cdot}38 + \frac{30{\cdot}61}{\Sigma C}\right) + C_2\left(13{\cdot}20 + \frac{28{\cdot}48}{\Sigma C}\right) + C_4\left(12{\cdot}406 + \frac{14{\cdot}042}{\Sigma C} - 1{\cdot}96\,\frac{C_1}{\Sigma C}\right) + C_6\left(13{\cdot}24 + \frac{17{\cdot}69}{\Sigma C}\right) + C_7\left(7{\cdot}04 + \frac{16{\cdot}53}{\Sigma C}\right) \quad . \quad (25)$$

The accuracy with which this equation predicted the molar volume of these 14 compounds was calculated.

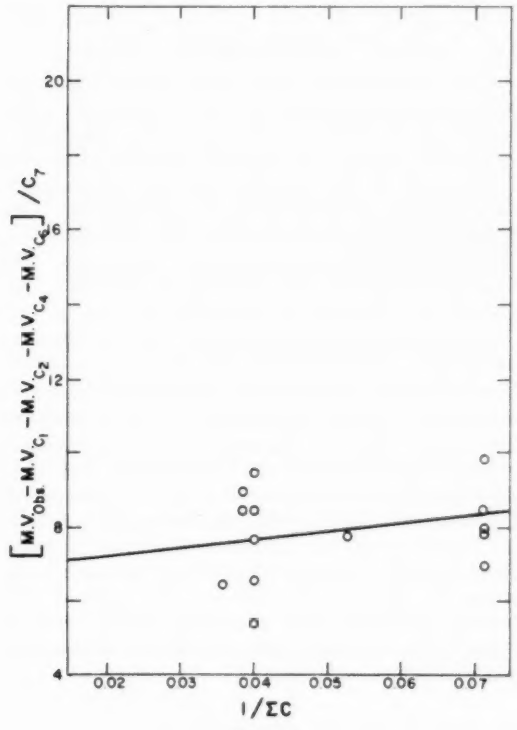

FIG 12

DETERMINATION OF v_7 AND K_7

The mean value of $\left[\frac{\text{M.V.}_{\text{calc}} - \text{M.V.}_{\text{obs}}}{\text{M.V.}_{\text{obs}}} \times 100\right]$ was found to be +0·20 per cent and the standard deviation from the mean was determined to be −0·80 per cent.

DISCUSSION

Equation (21) has been successfully used, along with four additional property equations, in a method of structural analysis which has been published elsewhere.[13] The detailed description of this equation has been given to illustrate the general method used to develop physical property equations to give structural information, and to show the limitations of such a method. One of the merits of the functional form (equation (4)) used here was that the coefficients were determined in such a way that $\left(v_i + \frac{K_i}{\Sigma C}\right)$ described the increment in molar volume of a C_i group. In this form, the limiting value of the increment (v_i) is apparent by inspection. In certain cases (C_3 and C_5), the necessary molar volume data were not available for compounds containing only groups of each of these types. In these cases, the v and K were not the characteristic values for one species only, as was the case for C_1, C_2, and C_4. Compounds containing C_2 and C_3 in the first case, and C_4 and C_5 in the latter case, had been used. Consequently, v_3 and K_3, and v_5 and K_5, have incorporated into their numerical values the interaction effects of the two species concerned. This placed a distinct limitation on the amount of structural information that could be obtained concerning fused-ring saturated and aromatic compounds. However, the manner in which these coefficients have been determined allows for further improvement as properties are determined for "new" compounds containing increased proportions of C_3 and C_5 groups. In this case, a redetermination of the coefficient for C_3 and C_5 groups should greatly improve our knowledge of the structural effects in fused-ring compounds.

Table VI presents the accuracy with which equation (21) expressed the molar volume of the API hydrocarbons. This accuracy was found adequate for using the equation in the structural analysis system already mentioned[13] to determine the average number of structural groups to within one carbon atom. In addition, a study of the "errors" in the various groups of compounds in this table indicate where it would be possible to improve the accuracy by determining further interaction terms. The highest errors occurred for the fused-ring compounds. This is to be expected in view of the fact that the C_5 coefficient was not based on direct experimental measurements. The accuracy for the fused saturated compounds could probably be improved by the determination of another interaction term. The errors for Kurtz and Sankin's molar volume equation have also been included in this table. These results indicated that the accuracy was almost identical for both equations for this particular group of hydrocarbons.

Considerable information concerning structural effects not covered by the five-type classification can be obtained by studying the differences between calculated and observed molar volumes. This has been done in the case of the branched paraffins. The results in Table I showed that the mean error resulting from using equation (8) (based on *n*-paraffins) to represent the branched paraffins, instead of equation (9) (based on branched paraffins), was only +0·31 per cent; *i.e.* a small number of branches in linear paraffins produced a relatively small effect on the molar volume. Consequently, it was felt that this result justified the use of equation (8) to represent all API 42 paraffins for structural analysis purposes. The results in column 2 of Table I indicated that, generally, as the number of branches increased the differences between calculated and observed molar volumes also increased. Insufficient data were available to determine the exact relationship between the number of branches and this difference. However, it would appear that when this difference exceeded +0·67 ml, more than one branch would be present.

Attention is also drawn to a comparison of equations (8) and (9). For the branched paraffins v_1 is greater, and K_1 smaller, than for the normal paraffins.

Interesting structural features of the molar volume were also revealed by the study of mono-, di-, tri-, and tetra-substituted *cyclo*hexanes. These results are given in Table II, Fig 4, and Table III. Table II and Fig 4 indicated that, for a *cyclo*hexane with one normal side chain, as the length of the side chain increased, the difference between observed and calculated molar volume decreased, the difference being essentially constant and equal to 1·4 ml for a side chain greater than 8 carbon atoms in length. The data in Table III showed that, for dimethyl *cyclo*hexanes, the value of ($M.V._{obs} - M.V._{calc}$) per methyl group increased in magnitude as one passed from ortho to meta to para substitution. Similarly, for trimethyl *cyclo*hexanes this difference per branch increased from 0·60 to 1·84 as one passed from 1,2,3-trimethyl *cyclo*hexane to 1,2,4- to 1,2,5-trimethyl *cyclo*hexane. For two tetramethyl *cyclo*hexanes, this difference per branch was very small and practically the same for the 1,2,3,5- and the 1,2,4,5-substitution positions. It should also be noted that, as the number of positions of attachment on the ring increased, the value of ($M.V._{obs} - M.V._{calc}$) per branch decreased.

As has already been indicated, considerable difficulty was experienced in obtaining suitable data for the fused-ring aromatics, and the data used were essentially hypothetical. Better accuracy would probably have been achieved if experimentally determined partial molar volumes in solution had been available.

The results of the study of the non-fused hydrocarbons, although only in its preliminary stages, are included to illustrate the general method of dealing with additional structural types. The values obtained for v_6, K_6, and v_7, K_7 clearly indicated C_6 and C_7 to be distinct structural types and differ from C_2 and C_4, into which groups they have sometimes been placed.[7,9] The fact that equations (23) and (25) expressed the molar volumes of non-fused saturates and aromatics, respectively, with a reasonable degree of accuracy (mean error of 0·2 per cent standard deviation of the error of less than 1 per cent) would seem to indicate that what remains to be done, in order to obtain an accurate equation for non-fused hydrocarbons, is to re-calculate v and K for each type as properties become available for compounds containing C_2 and C_6 only and C_4 and C_7 only, and, in due course, for compounds containing increasing proportions for C_6 and C_7 respectively. The effect of adding C_1 would then, in view of our earlier work, be determined as an interaction effect. Compounds containing both fused and non-fused groups have, so far, not been investigated, owing to lack of suitable data. The preliminary results appear to indicate that the interaction effects would have to be re-examined in this case. This is indicated by the fact that the C_2 interaction effect of fused-ring aromatics was not found to be applicable to non-fused aromatics containing C_2 groups.

CONCLUSION

It has been found possible to develop an expression in the form of equation (21) which gives the molar volume of 130 API 42 hydrocarbons in terms of five structural groups. A detailed description of the development of this equation has been presented to show the manner in which it was constructed. This procedure may be convenient for the development of other approximate physical property equations. The accuracy of equation (21) as far as the API 42 hydrocarbons are concerned is essentially the same as that proposed by Kurtz and Sankin, but it has the following advantages: This equation is in a convenient form for simultaneous solution with other physical property equations, the limiting values of the increments associated with each structural type as the molecule weight increases are evident by inspection, and so are the values of the five constants k_1 to k_5. An essential requirement of this equation is that when more than one ring occurs in a molecule the rings must be fused. However, other equations have been designed to express the molar volume of saturated compounds containing non-fused rings (equation (23)), as well as compounds containing both aromatic and saturated non-fused rings (equation (25)).

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DEVELOPMENT OF A MOLAR REFRACTION EQUATION SUITABLE FOR THE STRUCTURAL ANALYSIS OF HYDROCARBONS *

By M. L. BOYD † and D. S. MONTGOMERY †

SUMMARY

An equation has been developed which expresses, in terms of five structural groups, the molar refraction (Lorentz–Lorenz expression) of 118 pure hydrocarbons that were prepared by API Project 42.

This equation was specifically designed for structural analysis purposes. The accuracy with which it expresses the molar refraction of these compounds has been tabulated for comparison with the accuracies obtained for a similar expression previously derived for the molar volume.

INTRODUCTION

THE molar refraction as defined by Lorentz–Lorenz has long been recognized as a property that can be additively composed of empirical increments associated with the kinds of atoms present in the molecule, and upon the constitution, *i.e.* the arrangement and kind of binding between the atoms.[10] The aim of the present investigation was to develop an expression for the molar refraction of certain classes of hydrocarbons, in terms of five characteristic structural groups of a form that could be conveniently solved in a set of five simultaneous equations to yield quantitative information concerning the number of these groups present in the molecule.

Clausius [5] established the relation between the fraction of the volume of a substance that is actually occupied by the molecules and the dielectric constant. The electromagnetic theory of light has shown that the dielectric constant is equal to the square of the refractive index at very long wavelengths, and this has enabled Guye [20] to relate the van der Waal's b, which is approximately four times the actual volume occupied by the atoms, to the refractive index. If an equation of state of the van de Waal's form for liquids is assumed, the molar volume is proportional to van der Waal's b at constant temperature and pressure, provided the attractive forces between the molecules associated with the term $\frac{a}{v^2}$ are constant. This has suggested that an expression of the same functional form, in terms of the atomic structural groups, could be written for the Lorentz–Lorenz molar refraction as for the molar volume.[3] One of the aims of this investigation was to discover whether or not the overall accuracy, as well as the accuracy within each structural type, was of the same order as in the molar volume equation previously derived.[3]

The third paper of this series has been reported elsewhere,[19] and gives the accuracy that can be achieved on solving the molar refraction and molar volume equations in a simultaneous set of five equations.

The development of a molar refraction equation for structural analysis is not the same problem as developing the most accurate expression in the light of a complete knowledge of the chemical structure. For structural analysis the molar refraction must be described in terms of a restricted number of structural types. In this particular instance it is limited to five. It is assumed, in hydrocarbon structural analysis, that no prior information is available as to the structure, other than that the compound is composed of no more than the given number of structural types. This results in a certain amount of over-correction of the expression for the molar refraction, as was the case with the molar volume equation. Nevertheless, the accuracies achieved are within the limits demanded by many chemical engineering requirements, and therefore may be of interest in the field of chemical technology as well as in analytical chemistry.

From an historical point of view the refractive index of liquids is a physical property that has been measured with a relatively high degree of accuracy for many years. During the past fifty years, many linear equations have been proposed expressing the refractive index as a function of molecular weight (Schoorl [23]), as a function of the number of carbon atoms (Francis [11] and Smittenberg [25]), and as a function of the boiling point (Mibashan [18]). Equations of this type have been largely used for calculating refractive indices of unsynthesized members of a homologous series. The molar refraction, as opposed to the refractive index, has been used more extensively for the study of chemical structure. The first expression for the molar refraction was that of Berthelot [2] in 1856, which was followed by two other relations, that of Gladstone and Dale [12] in 1863, and Landolt's [16] equation in 1864. Following the deduction by Lorentz, in 1880, of the Lorentz–Lorenz equation [17] from the electro-magnetic theory of light, numerous

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sets of additive increments have been based upon this relation, beginning with Landolt in 1882 and followed by Bruhl,[4] Eisenlohr,[8] Eykman,[9] von Auwers,[1] and Vogel.[26] Recently, Rossini [21] has determined an equation which expresses the molar refraction of various sets of homologous series of API hydrocarbons. Huggins [13] has used the Gladstone and Dale expression for a similar study.

Throughout this work the molar refraction is defined as:

$$\text{M.R.} = \frac{n^2 - 1}{n^2 + 2} \cdot \frac{M}{d} \quad . \quad . \quad . \quad (1)$$

where n is the refractive index for the sodium D line at 20° C, d is the density at the same temperature in grams per millilitre, and M is the gram molecular weight (C = 12·010, H = 1·008). As mentioned previously, the intimate relation between this expression (which is the actual volume of the spherical conducting molecules in a gram mole) and van der Waal's b, suggested that the contributions of the five structural groups should be expressed in terms of this function, to maintain a high degree of symmetry between the functional form of the molar volume and molar refraction equations and thus facilitate the solution of the set of simultaneous equations.

DEVELOPMENT OF THE MOLAR REFRACTION EQUATION

Definition of Structural Types

The five-type carbon classification chosen here was identical to that used for a molar volume equation.[3] The five carbon linkages may be briefly defined as follows:

- C_1 = number per molecule of CH_3, CH_2, CH, and C groups in linear and branched chains.
- C_2 = number per molecule of CH_2 groups in saturated rings, including the case where the hydrogen atoms may be replaced by branched or linear chains.
- C_3 = number per molecule of CH groups which are junctions between fused saturated rings, as well as similarly situated groups where the hydrogen is replaced by linear or branched chains.
- C_4 = number per molecule of CH groups in aromatic rings, including the case where the hydrogen may be replaced by branched or linear chains.
- C_5 = number per molecule of $-\overset{|}{\underset{|}{C}}-$ groups which are junctions between fused aromatic rings, as well as junctions between saturated and aromatic rings.

Form of the Equation

In the initial stages of the work to obtain structural information from the molar refraction, an attempt was made to develop an equation analogous to Kurtz and Sankin's molar volume equation.[15] This was unsuccessful because of the inability to obtain a constant double bond increment for the molar refraction.

The form of the equation is identical to that which has already been used for the molar volume.[3] Since the molar volume and the molar refraction are very intimately related properties, it was anticipated that the same functional form could be used in both cases. Consequently, as a result of the equation developed for the molar volume,[3] the following equation was taken as the initial form of the molar refraction equation:

$$\text{M.R.} = C_1\left(r_1 + \frac{h_1}{\Sigma C}\right) + C_2\left(r_2 + \frac{h_2}{\Sigma C}\right) + C_3\left(r_3 + \frac{h_3}{\Sigma C}\right) + C_4\left(r_4 + \frac{h_4}{\Sigma C}\right) + C_5\left(r_5 + \frac{h_5}{\Sigma C}\right) \quad (2)$$

r_{1-5} and h_{1-5} are characteristic constants for the five characteristic linkages. The determination of these coefficients constitutes the main body of this work.

DETERMINATION OF THE COEFFICENTS

The coefficients in equation (2) were determined in exactly the same manner as was used in the case of the molar volume.[3] The two general methods used can be briefly summarized as follows. For the case

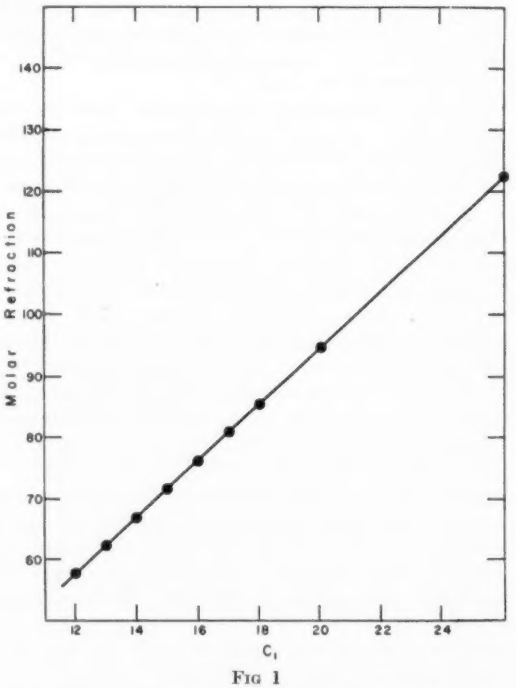

FIG 1

DETERMINATION OF r_1 AND h_1 FROM API 42 n-PARAFFINS

of a molecule containing only one species of carbon groups, C_i, equation (2) assumed the following form:

$$\text{M.R.} = r_i C_i + h_i \quad . \quad . \quad . \quad (3)$$

In this case, when the molar refraction was plotted *v.* C_i, the resultant straight line had a slope of r_i and an intercept h_i.

A slightly different technique was used for the case where the molecule contained more than one species of groups. This case may best be illustrated by considering the following example: If a molecule contains C_a and C_b groups, where the coefficient for C_a is known and it is desired to determine the coefficient of C_b, $\dfrac{\text{M.R.} - C_a\left(r_a + \dfrac{h_a}{\Sigma C}\right)}{C_b}$ is plotted *v.* $1/\Sigma C$, and the resultant straight line has a slope of h_b and an intercept of r_b.

Determination of r_1 and h_1

The molar refraction was available for nine *n*-paraffins on the list of API Project 42.[22] These values were plotted against the number of carbon atoms in the molecule (Fig 1). The equation of the

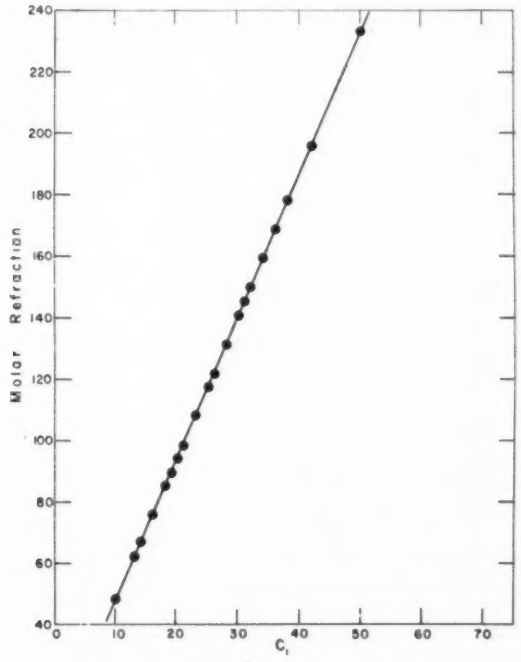

FIG 2

DETERMINATION OF r_1 AND h_1 FROM API BRANCHED PARAFFINS

resultant straight line was determined by the method of least squares and found to be:

$$\text{M.R.} = 4{\cdot}623C_1 + 2{\cdot}314 \quad . \quad . \quad (4)$$

Although it was considered desirable to have the C_1 coefficients in equation (2) represent an infinite linear chain of CH_2 groups and not to contain the effects of branching, a study was made of the branched paraffins in a similar manner to that already given for the *n*-paraffins. The molar refraction of 37 branched

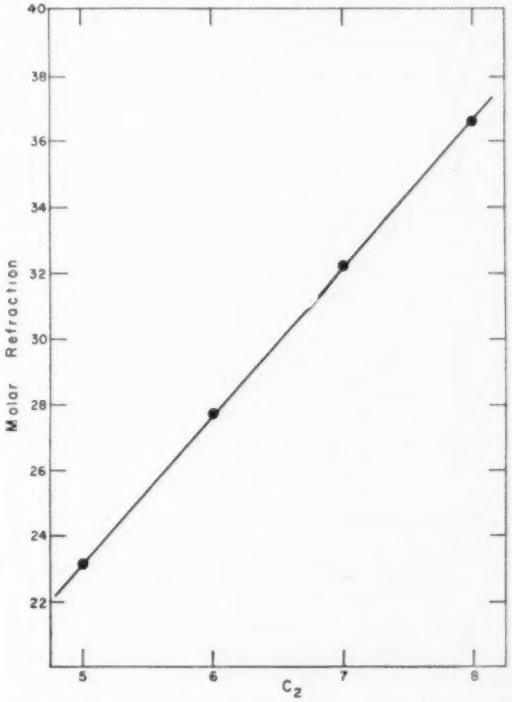

FIG 3

DETERMINATION OF r_2 AND h_2 FROM DATA OF WARD AND KURTZ

paraffins on the API 42 list was plotted against the number of carbon atoms in the molecule (Fig 2). The resultant straight line was found, by the method of least squares, to have the following equation:

$$\text{M.R.} = 4{\cdot}637C_1 + 1{\cdot}751 \quad . \quad . \quad (5)$$

Determination of r_2 and h_2

These quantities were calculated in a manner similar to that used for the calculation of r_1 and h_1, using the physical properties given by Ward and Kurtz [27] for *cyclo*pentane, *cyclo*hexane, *cyclo*heptane, and *cyclo*octane. The molar refraction was plotted against the number of carbon atoms in the molecule (Fig 3). By the method of least squares, the equation of this line was found to be:

$$\text{M.R.} = 4{\cdot}468C_2 + 0{\cdot}868 \quad . \quad . \quad (6)$$

Determination of r_3 and h_3

Since no compounds existed containing C_3 groups only, the second technique for the determination of

the coefficients, described on p. 361, had to be used. The group C_3 always exists in the presence of C_2 groups. Hence, the following compounds from the API 42 list were used to determine r_3 and h_3: bi*cyclo*-

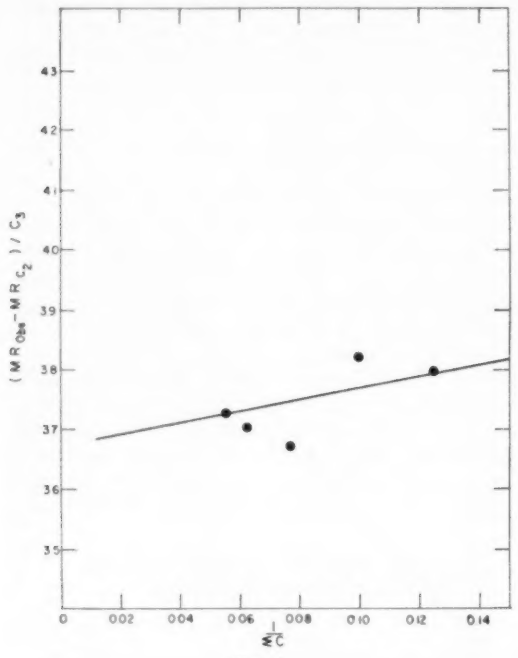

FIG 4

DETERMINATION OF r_3 AND h_3 FROM API 42 DATA FOR FUSED NAPHTHENES

octane 543, decahydronaphthalene 569 and 570, perhydrofluorene 561, perhydropyrene 578, and perhydrochrysene 575. The quantity

$$\left[\text{M.R.}_{\text{obs}} - \text{C}_2\left(4{\cdot}468 + \frac{0{\cdot}868}{\Sigma\text{C}}\right)\Big/\text{C}_3\right]$$

was calculated for each compound and plotted against $1/\Sigma C$. The result is shown in Fig 4. By the method of least squares, r_3 was determined to be 3·693 and h_3 to be 0·3395.

Determination of r_4 and h_4

The following compounds were used to calculate r_4 and h_4: benzene (properties from Egloff [7]); *cyclo*-octatetraene (properties by Eccleston [6]), and *cyclo*-pentadiene (Ward and Kurtz [27]). It will be noted that these compounds are not all of the same type—*cyclo*pentadiene contains a C_2 group, while benzene and *cyclo*-octatetraene contain C_4 groups only. In order to apply method 1 for calculating the coefficients, it was desirable to have compounds containing C_4's only. However, due to the scarcity of available data this was not possible. The contribution of the CH_2 in *cyclo*pentadiene was deducted from its molar refraction. This procedure was found successful in the case of the molar volume,[3] and hence was used again. This amounted to considering a hypothetical compound C_4H_4 having a molar refraction of $\left[\text{M.R.}_{\textit{cyclo}\text{pentadiene}} - 1\left(4{\cdot}468 + \frac{0{\cdot}868}{5}\right)\right]$. The graph of molar refraction v. the number of carbon atoms in the molecule is given in Fig 5. The least square equation of this line was found to be:

$$\text{M.R.} = 4{\cdot}5445\text{C}_4 - 1{\cdot}021 \quad . \quad . \quad (7)$$

Determination of r_5 and h_5

These constants were based on properties of fused-ring aromatic compounds, containing both C_4 and C_5 groups, since no compounds existed containing C_5's only. Some difficulty was experienced in obtaining

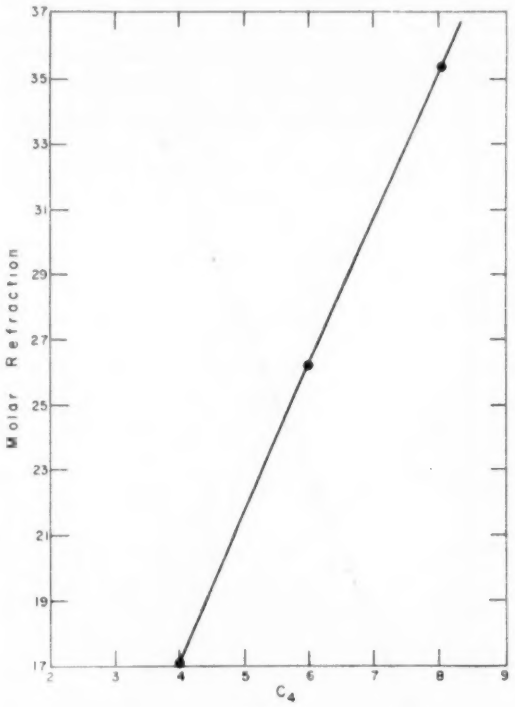

FIG 5

DETERMINATION OF r_4 AND h_4

suitable liquid state data, since most fused-ring aromatics are solid at 20° C. The molar refraction data used here refer to measurements made by van Krevelen [24] of the compounds in dilute benzene solution. van Krevelen has referred to these data as "hypothetical liquid state data." [14] As with the

case of C_3, the second method of calculating the coefficients was used. The quantity

$$\left[\frac{\text{M.R.}_{\text{obs}} - C_4\left(4{\cdot}5445 - \frac{1{\cdot}021}{\Sigma C}\right)}{C_5}\right]$$

was calculated for each of the following compounds: naphthalene, anthracene, phenanthrene, pyrene, naphthacene, benzanthracene, chrysene, and dibenzanthracene. These values were plotted against $1/\Sigma C$. The result is shown in Fig 6. From this, r_5

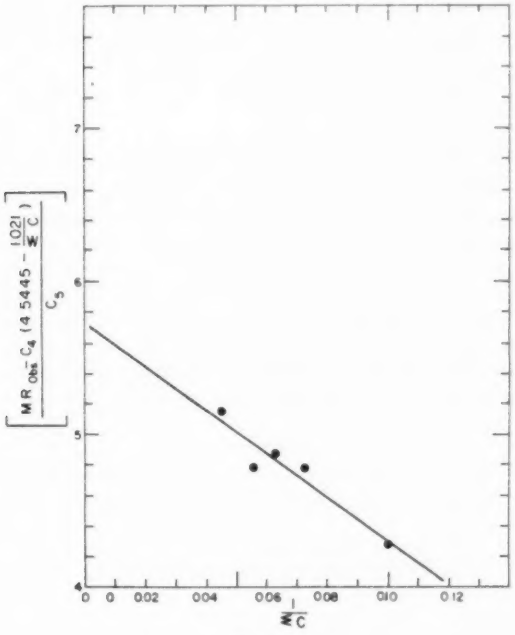

FIG 6

DETERMINATION OF r_5 AND h_5

was determined to be 5·734 and h_5 to be −14·333.

At this stage in the development of this equation, the values of r_{1-5} and h_{1-5} just determined were substituted into equation (2) and the following expression for the molar refraction was obtained:

$$\text{M.R. at } 20^\circ\text{ C and 1 atm} = C_1\left(4{\cdot}623 + \frac{2{\cdot}314}{\Sigma C}\right) + C_2\left(4{\cdot}468 + \frac{0{\cdot}868}{\Sigma C}\right) + C_3\left(3{\cdot}693 + \frac{0{\cdot}3395}{\Sigma C}\right) + C_4\left(4{\cdot}5445 - \frac{1{\cdot}021}{\Sigma C}\right) + \left(5{\cdot}734 - \frac{14{\cdot}333}{\Sigma C}\right) \quad (8)$$

Equation (8) was used to calculate the molar refraction for appropriate classes of compounds on the API 42 list [22] and to compare the results with the experimental values. The result of this series of calculations revealed that the error was particularly high for three classes, namely, the monocyclic saturates, monocyclic aromatics, and fused-ring aromatics. In considering the accuracy of the equation, the objective was to attain approximately the same order of accuracy as that which had been obtained in the development of a molar volume equation.[3] To reduce the errors for the three classes just mentioned, a study of the interactions between various types of structural groups was made in a manner analogous to that which had been done in the study of the molar volume.[3]

Interaction between C_1 and C_2 in Monocyclic Saturates

When equation (8) was used to calculate the molar refraction of monocyclic saturates on the API 42 list, the mean error between calculated and observed values was found to be three times larger than was obtained under identical circumstances for the molar volume equation.[3] To reduce this error, a study was made of a series of *n*-alkyl *cyclo*hexanes whose properties have been given by Ward and Kurtz.[27] In the case of the interaction terms in the molar volume equation, it had been found possible to express the difference between calculated and observed values as a linear function of $C_1/\Sigma C$. For the sake of mathematical simplicity in using the equation for simultaneous solution in structural analysis, it is desirable that the correction term should become zero when either C_1 or C_2 becomes zero. This means that in a linear plot between "difference between calculated and observed molar refraction values" and $C_1/\Sigma C$ it is desirable that this line should pass through the origin. For each of the *n*-substituted *cyclo*hexanes, two quantities were calculated $\left(r_2 + \frac{h_2}{\Sigma C}\right)_{\text{calc}}$, *i.e.* the molar refraction increment of a C_2 group as calculated by equation (8), and $\left(r_2 + \frac{h_2}{\Sigma C}\right)_{\text{obs}}$, *i.e.* the actual increment of a C_2 group. This quantity is equal to

$$\left[\frac{\text{M.R.}_{\text{obs}} - C_1\left(4{\cdot}623 + \frac{2{\cdot}314}{\Sigma C}\right)}{C_2}\right]$$

TABLE I

Illustration of the Interaction Effect between C_1 and C_2 in Monocyclic Saturates

Compound	$\left(r_2 + \frac{h_2}{\Sigma C}\right)_{\text{calc}}$	$\left(r_2 + \frac{h_2}{\Sigma C}\right)_{\text{obs}}$	$C_1/\Sigma C$	$\left[\left(r_2 + \frac{h_2}{\Sigma C}\right)_{\text{calc}} - \left(r_2 + \frac{h_2}{\Sigma C}\right)_{\text{obs}}\right]$
*cyclo*Hexane	4·613	4·627	0	−0·014
Methyl *cyclo*hexane	4·593	4·596	0·14	−0·004
Ethyl *cyclo*hexane	4·578	4·555	0·25	+0·023
Propyl *cyclo*hexane	4·564	4·522	0·33	+0·042
Butyl *cyclo*hexane	4·555	4·506	0·40	+0·049
Amyl *cyclo*hexane	4·547	4·470	0·45	+0·077
Octyl *cyclo*hexane	4·530	4·433	0·57	+0·097
Decyl *cyclo*hexane	4·523	4·412	0·625	+0·110
1-*cyclo*Hexyl eicosane	4·501	4·393	0·77	+0·108

These data are expressed graphically in Fig 7. This figure indicated that a linear relationship existed between $\left[\left(r_2+\frac{h_2}{\Sigma C}\right)_{calc}-\left(r_2+\frac{h_2}{\Sigma C}\right)_{obs}\right]$ and $C_1/\Sigma C$. By inspection of this graph, it was apparent that this

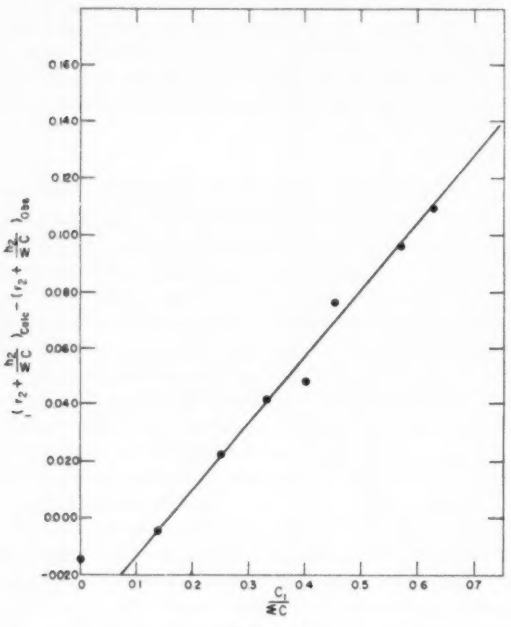

FIG 7

DETERMINATION OF THE INTERACTION EFFECT BETWEEN C_1 AND C_2

line did not pass through the origin. The equation of this line (least squares fit to the type equation $y = ax + b$) was determined to be:

$$\left(r_2+\frac{h_2}{\Sigma C}\right)_{calc}-\left(r_2+\frac{h_2}{\Sigma C}\right)_{obs} = 0{\cdot}189\,\frac{C_1}{\Sigma C}-0{\cdot}020 \quad (9)$$

Since, as had already been mentioned, it was desirable for structural analysis to have this line pass through the origin, the least square line of the type $y = ax$ was calculated and found to be:

$$\left(r_2+\frac{h_2}{\Sigma C}\right)_{calc}-\left(r_2+\frac{h_2}{\Sigma C}\right)_{obs} = 0{\cdot}136\,\frac{C_1}{\Sigma C} \quad (10)$$

Since a considerable error would be introduced by applying equation (10), instead of equation (9), to the API data, the effect of C_1 on C_2 was recalculated on the basis of the 26 API mononuclear saturates and was determined to be:

$$\left(r_2+\frac{h_2}{\Sigma C}\right)_{calc}-\left(r_2+\frac{h_2}{\Sigma C}\right)_{obs} = 0{\cdot}245\,\frac{C_1}{\Sigma C} \quad (11)$$

This could be rearranged as follows:

$$\left(r_2+\frac{h_2}{\Sigma C}\right)_{obs} = \left(r_2+\frac{h_2}{\Sigma C}\right)_{calc}-0{\cdot}245\,\frac{C_1}{\Sigma C} \quad (12)$$

Equation (12) was thence used as a "correction" term in equation (8), and hence the molar refraction of mononuclear saturates was given by the following expression:

$$\text{M.R.} = C_1\left(4{\cdot}623+\frac{2{\cdot}314}{\Sigma C}\right) + C_2\left(4{\cdot}468+\frac{0{\cdot}868}{\Sigma C}-0{\cdot}245\,\frac{C_1}{\Sigma C}\right) \quad (13)$$

This corrected equation reduced the molar refraction increment of a C_2 group by an amount equal to $0{\cdot}245\,\frac{C_1}{\Sigma C}$.

Interaction between C_1 and C_4 in Monocyclic Aromatics

When equation (8) was used to calculate the molar refraction of the monocyclic aromatics on the API 42 list, the mean percentage difference between calculated and observed values was determined to be 1·8 per cent. In view of the success of the earlier work on the molar volume [3] of monocyclic aromatics, an attempt was made to reduce this error by studying the effect of the interaction between C_1 and C_4 in a series of *n*-alkyl benzenes whose properties have been

TABLE II

The Interaction Effect between C_1 and C_4 in Monocyclic Aromatics

Compound	$\left(r_4+\frac{h_4}{\Sigma C}\right)_{calc}$	$\left(r_4+\frac{h_4}{\Sigma C}\right)_{obs}$	$C_1/\Sigma C$	$\left[\left(r_4+\frac{h_4}{\Sigma C}\right)_{calc}-\left(r_4+\frac{h_4}{\Sigma C}\right)_{obs}\right]$
Benzene	4·374	4·366	0	0·008
Toluene	4·398	4·356	0·14	0·042
Ethylbenzene	4·416	4·324	0·25	0·092
n-Propylbenzene	4·431	4·303	0·33	0·128
n-Butylbenzene	4·442	4·325	0·40	0·117
n-Amylbenzene	4·452	4·272	0·45	0·180
n-Hexylbenzene	4·459	4·261	0·50	0·198
n-Heptylbenzene	4·466	4·253	0·54	0·213
n-Octylbenzene	4·472	4·223	0·57	0·249
n-Decylbenzene	4·481	4·210	0·625	0·271
1-Phenyleicosane	4·505	4·177	0·77	0·328

given by Ward and Kurtz.[27] For each of these compounds, two quantities were calculated: $\left(r_4+\frac{h_4}{\Sigma C}\right)_{calc}$, *i.e.* the molar refraction increment of a C_4 group as calculated by equation (8); and $\left(r_4+\frac{h_4}{\Sigma C}\right)_{obs}$, *i.e.* the actual molar refraction increment of a C_4 group. This quantity is equal to

$$\left[\text{M.R.}_{obs}-C_1\left(4{\cdot}623+\frac{2{\cdot}314}{\Sigma C}\right)\right]\Big/C_4.$$

These data are tabulated in Table II.

In addition, these data have been presented

graphically in Fig 8. This figure indicated that a linear relationship existed between

$$\left[\left(r_4 + \frac{h_4}{\Sigma C}\right)_{calc} - \left(r_4 + \frac{h_4}{\Sigma C}\right)_{obs}\right]$$

and $C_1/\Sigma C$. The equation of this line, which passed

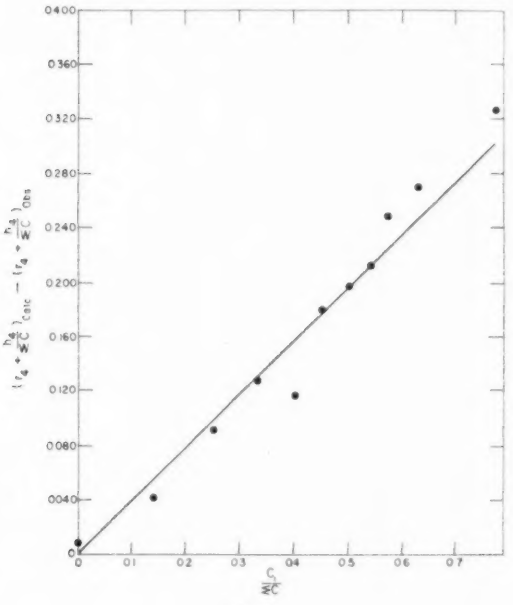

FIG 8

DETERMINATION OF THE INTERACTION EFFECT BETWEEN C_1 AND C_4

through the origin, was determined to be (omitting *n*-butyl benzene):

$$\left(r_4 + \frac{h_4}{\Sigma C}\right)_{calc} - \left(r_4 + \frac{h_4}{\Sigma C}\right)_{obs} = 0{\cdot}396\,\frac{C_1}{\Sigma C} \quad (14)$$

This could be rearranged as follows:

$$\left(r_4 + \frac{h_4}{\Sigma C}\right)_{obs} = \left(r_4 + \frac{h_4}{\Sigma C}\right)_{calc} - 0{\cdot}396\,\frac{C_1}{\Sigma C} \quad (15)$$

In other words, this amounted to reducing the molar refraction increment by an amount equal to $\left(0{\cdot}396\,\frac{C_1}{\Sigma C}\right)$. Consequently the C_4 term in equation (8) was "corrected" in a manner similar to that already described for the C_2 term. The corrected molar refraction equation became:

$$\begin{aligned} \text{M.R.} = {} & C_1\left(4{\cdot}623 + \frac{2{\cdot}314}{\Sigma C}\right) \\ & + C_2\left(4{\cdot}468 + \frac{0{\cdot}868}{\Sigma C} - 0{\cdot}245\,\frac{C_1}{\Sigma C}\right) \\ & + C_3\left(3{\cdot}693 + \frac{0{\cdot}3395}{\Sigma C}\right) \\ & + C_4\left(4{\cdot}5445 - \frac{1{\cdot}021}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right) \\ & + C_5\left(5{\cdot}734 - \frac{14{\cdot}333}{\Sigma C}\right) \quad (16) \end{aligned}$$

Interaction Effects of C_2 in Fused-ring Aromatics

When equation (16) was used to calculate the molar refraction of the API fused-ring aromatics, the error was approximately 2 per cent. It was noted that for those compounds which contained C_2 groups the error was particularly high (mean value of 3·5 per cent). In the course of the earlier work in developing a molar volume equation,[3] it was found that this effect could best be dealt with by applying a correction term to C_4 which expressed the relationship between the difference in calculated and observed values, and $C_2/\Sigma C$. This same method was applied. It was based on the API fused-ring aromatics containing C_2 groups. For each compound the following two quantities were calculated:

$$\left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{calc} \text{ and } \left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{obs}$$

These data are given in Table III.

These data are presented graphically in Fig 9. This graph indicated that again a linear relationship existed between

$$\left[\left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{calc} - \left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{obs}\right]$$

TABLE III

API 42 Compound	$\left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{calc}$	$\left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{obs}$	$C_2/\Sigma C$	$\left[\left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{calc} - \left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{obs}\right]$
574	4·488	1·697	0·556	2·791
16	4·250	3·471	0·12	0·779
188	4·266	3·554	0·16	0·712
165	4·383	1·90	0·385	2·483
179	4·383	4·250	0·154	0·133
173	4·244	3·494	0·129	0·750

and $C_2/\Sigma C$. The equation of this line (omitting #179) which passes through the origin was:

$$\left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{calc} - \left(r_4 + \frac{h_4}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C}\right)_{obs} = 5{\cdot}701\,C_2/\Sigma C \quad (17)$$

As in the case of the C_1 interactions, equation (17) was used to "correct" equation (16). The correction consisted of decreasing the molar refraction incre-

ment for C_4 by an amount equal to $5{\cdot}701\,C_2/\Sigma C$. The molar refraction equation, with the three correction terms just described, can be written as follows:

$$\text{M.R.} = C_1\left(4{\cdot}623 + \frac{2{\cdot}314}{\Sigma C}\right) + C_2\left(4{\cdot}468 + \frac{0{\cdot}868}{\Sigma C} - 0{\cdot}245\,\frac{C_1}{\Sigma C}\right) + C_3\left(3{\cdot}693 + \frac{0{\cdot}3395}{\Sigma C}\right) + C_4\left(4{\cdot}5445 - \frac{1{\cdot}021}{\Sigma C} - 0{\cdot}396\,\frac{C_1}{\Sigma C} - 5{\cdot}701\,\frac{C_2}{\Sigma C}\right) + C_5\left(5{\cdot}734 - \frac{14{\cdot}333}{\Sigma C}\right) \quad (18)$$

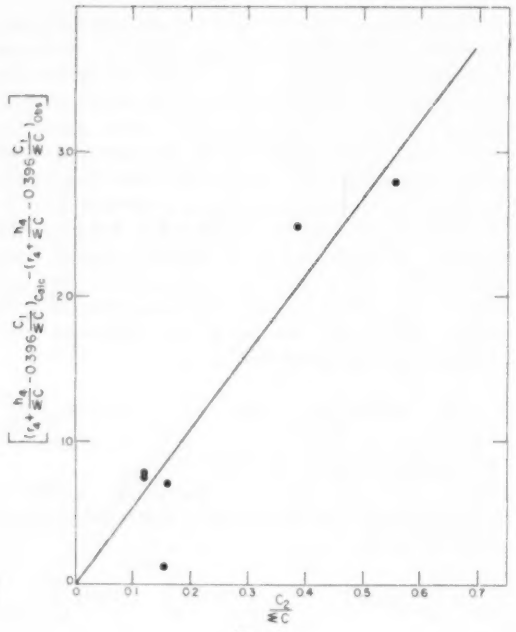

FIG 9

DETERMINATION OF THE INTERACTION EFFECTS OF C_2 IN FUSED-RING AROMATICS

Accuracy of Proposed Molar Refraction Equation

The molar refraction was calculated according to equation (18) for 118 hydrocarbons prepared by API Project 42.[22] In each case the percentage error has been calculated. The results are contained in Table IV. The overall accuracy with which this equation predicted the molar refraction of this particular group of hydrocarbons is tabulated in Table V. It was stated earlier that the objective was to achieve approximately the same order of accuracy as was obtained for the molar volume equation, which was expressed in terms of the same parameters. For this reason, a summary of the accuracy for the molar volume equation has been included in Table V for comparison.

TABLE IV

Calculation of Molar Refraction by Equation (18) of the API 42 Hydrocarbons

API 42 Compound No.	M.R.$_{calc}$	M.R.$_{obs}$	[M.R.$_{calc}$ − M.R.$_{obs}$]	$\left[\frac{\text{M.R.}_{calc} - \text{M.R.}_{obs}}{\text{M.R.}_{obs}} \times 100\right]$
n-Paraffins				
528	57·79	57·8	−0·01	−0·017
529	62·41	62·4	+0·09	+0·144
531	67·04	67·0	+0·04	+0·054
532	71·66	71·7	−0·04	−0·056
534	76·28	76·3	−0·02	−0·026
535	80·90	80·9	0·0	0·0
537	85·53	85·5	+0·03	+0·035
540	94·77	94·8	−0·03	−0·032
106	122·51	122·5	+0·01	+0·008
Branched Paraffins				
549	48·54	48·31	+0·23	+0·48
546	62·41	62·24	+0·17	+0·27
512	67·04	67·0	+0·04	+0·06
556	67·04	66·08	+0·96	+1·45
545	76·28	76·1	+0·18	+0·24
557	85·53	85·23	+0·30	+0·35
500	90·15	90·0	+0·15	+0·17
510	94·77	94·4	+0·37	+0·39
511	94·77	94·7	+0·07	+0·07
554	99·40	99·35	+0·05	+0·05
163	108·64	108·6	+0·04	+0·04
25	117·89	117·7	+0·11	+0·09
1	122·51	122·2	+0·31	+0·25
2	122·51	122·3	+0·21	+0·17
3	122·51	122·3	+0·21	+0·17
4	122·51	122·1	+0·41	+0·34
22	122·51	122·0	+0·51	+0·42
23	122·51	121·8	+0·71	+0·58
27	122·51	122·3	+0·21	+0·17
51	122·51	122·3	+0·21	+0·17
53	122·51	121·9	+0·61	+0·50
55	122·51	122·0	+0·51	+0·42
67	122·51	122·3	+0·21	+0·17
109	122·51	122·4	+0·11	+0·09
5	131·76	131·5	+0·26	+0·20
63	131·76	131·5	+0·26	+0·20
184	131·76	131·7	+0·06	+0·05
6	141·00	140·8	+0·20	+0·14
8	145·63	145·5	+0·13	+0·09
7	150·25	150·0	+0·25	+0·17
191	150·25	150·4	−0·15	−0·10
107	159·50	159·5	0·0	0·0
164	159·50	159·7	−0·20	−0·12
133	168·74	169·0	−0·26	−0·15
134	177·99	178·2	−0·21	−0·12
182	196·48	196·4	+0·08	+0·04
59	233·46	233·6	−0·14	−0·60
Monocyclic Saturates				
539	64·64	64·9	−0·26	−0·39
514	64·64	64·7	−0·06	−0·086
573	69·58	69·55	+0·03	+0·05
572	73·89	74·15	−0·26	−0·34
542	88·10	87·90	+0·20	+0·23
504	87·76	87·7	+0·06	+0·07
509	106·26	106·3	−0·04	−0·04
110	115·85	115·7	+0·15	+0·126
88	115·496	115·5	−0·004	−0·0035
117	120·47	120·6	−0·13	−0·11
64	120·47	120·0	+0·47	+0·39
100	120·12	120·6	−0·48	−0·40
102	120·12	120·2	−0·08	−0·07
75	120·12	119·9	+0·22	+0·18
104	120·12	120·1	+0·02	+0·015
76	120·12	119·9	+0·22	+0·18
77	120·12	119·9	+0·22	+0·18
78	120·12	119·9	+0·22	+0·18
162	120·12	120·2	−0·08	−0·07
74	125·10	125·0	+0·10	+0·08
60	127·74	124·5	+0·24	+0·20
91	129·36	129·7	−0·34	−0·26
180	134·35	134·4	−0·05	−0·039
69	143·24	143·1	+0·14	+0·10
136	161·72	162·0	−0·28	−0·17
138	180·20	180·5	−0·30	−0·16
Fused-ring Saturates				
562	94·49	94·8	−0·31	−0·32
563	94·49	94·4	+0·09	+0·11
527	78·47	78·5	−0·03	−0·04
125	115·25	115·9	−0·65	−0·56
178	118·21	118·1	+0·11	+0·10
141	115·25	115·6	−0·35	−0·30
544	94·53	94·81	−0·28	−0·30
175	113·00	113·4	−0·40	−0·35
166	113·04	113·5	−0·45	−0·40
62	140·71	140·6	+0·11	+0·075
177	129·60	129·4	+0·20	+0·15

TABLE IV (*contd.*)

Calculation of Molar Refraction by Equation (18) *of the API 42 Hydrocarbons*

API 42 Compound No.	M.R.$_{calc}$	M.R.$_{obs}$	[M.R.$_{calc}$ − M.R.$_{obs}$]	$\left[\frac{\text{M.R.}_{calc} - \text{M.R.}_{obs}}{\text{M.R.}_{obs}} \times 100\right]$
Fused-ring Saturates				
193	120·37	120·4	−0·03	−0·026
108	113·29	113·4	−0·11	−0·10
196	108·63	108·6	+0·03	+0·028
543	34·93	34·85	+0·08	+0·23
569–70	43·89	44·08	−0·19	−0·40
561	55·69	55·48	+0·21	+0·38
578	67·51	67·44	+0·07	+0·10
575	76·46	76·55	−0·09	−0·11
Monocyclic Aromatics				
538	63·78	63·64	+0·14	+0·22
513	63·78	63·6	+0·18	+0·28
571	73·08	72·94	+0·14	+0·19
502	87·00	86·8	+0·20	+0·24
87	114·82	114·3	+0·52	+0·46
10	114·82	114·7	+0·12	+0·10
99	119·44	119·3	+0·14	+0·12
101	119·44	119·0	+0·44	+0·37
79	119·44	118·9	+0·54	+0·45
103	119·44	119·0	+0·44	+0·37
80	119·44	118·9	+0·54	+0·45
81	119·44	119·0	+0·44	+0·37
82	119·44	119·0	+0·44	+0·37
152	119·44	119·0	+0·44	+0·37
161	119·44	119·6	−0·16	−0·13
9	124·08	123·6	+0·48	+0·39
54	128·71	128·7	+0·01	+0·011
168	133·34	133·5	−0·16	−0·13
68	142·61	142·0	+0·61	+0·43
Fused-ring Aromatics				
567	49·02	48·75	+0·27	+0·56
574	74·98	75·73	−0·75	−0·99
559	96·47	95·50	+0·97	+1·01
16	113·08	112·7	+0·38	+0·34
188	111·90	112·7	−0·80	−0·71
174	115·18	114·5	+0·68	+0·60
165	114·48	113·9	+0·58	+0·51
173	140·55	140·5	+0·05	+0·04

Polycyclic Non-fused Hydrocarbons

It is apparent, from the five carbon types described on p. 360, that this classification is restricted to certain specific classes of compounds. Of the compounds on the API 42 list,[22] the polycyclic non-fused structures were not included in this classification. If the junctions were to be " forced " into the present five-type classification, by considering them as C_2 or C_4, then the equation, $2C_1 + 2C_2 + C_3 + C_4 =$ total number of hydrogen atoms, would not be satisfied. In the earlier work in developing a molar volume equation[3] it was shown that, to study polycyclic non-fused hydrocarbons, two additional structural groups had to be considered. These are the " so-called isolated " ring junctions, in both saturated and aromatic rings, and were defined briefly as follows:

C_6 = number per molecule of CH groups in a saturated ring which are the " junctions " between non-fused rings, or in other words they represent CH_2 groups in saturated rings where one hydrogen has been replaced by a ring R or a chain terminating in a ring $-(C_1)_nR$.

C_7 = number per molecule of $-C-$ groups in aromatic rings which constituted " junctions " between non-fused rings, *i.e.* C_7 = the number of CH groups in aromatic rings where the hydrogen was replaced by a ring R or a chain terminating in a ring $-(C_1)_nR$.

Hence, to study non-fused hydrocarbons, an equation of the following form was assumed:

$$\text{M.R.} = C_1\left(r_1 + \frac{h_1}{\Sigma C}\right) + C_2\left(r_2 + \frac{h_2}{\Sigma C}\right) + C_4\left(r_4 + \frac{h_4}{\Sigma C}\right) + C_6\left(r_6 + \frac{h_6}{\Sigma C}\right) + C_7\left(r_7 + \frac{h_7}{\Sigma C}\right) \quad (19)$$

Determination of r_6 and h_6

These coefficients were determined by the method described on p. 361, *i.e.* the method for the case where the molecule contained more than one species of groups. In this instance, data were lacking for a sufficient number of compounds containing C_2 and C_6 groups only and, hence, r_6 and h_6 were based on compounds containing C_1, C_2, and C_6 groups. Ten non-fused naphthenes from the API 42 list were used. For each of these compounds, the value of

$$\left[\text{M.R.}_{obs} - C_1\left(4{\cdot}623 + \frac{2{\cdot}314}{\Sigma C}\right) - C_2\left(4{\cdot}468 + \frac{0{\cdot}868}{\Sigma C} - 0{\cdot}245\,\frac{C_1}{\Sigma C}\right)\right] \Big/ C_6$$

was calculated. This quantity was plotted *v.* $1/\Sigma C$.

TABLE V

Accuracy of Molar Refraction Equation and Its Comparison with the Authors' Molar Volume Equation, as Applied to API 42 Hydrocarbons

Class of compound	No. in class	Authors' M.R. equation		Authors' M.V. equation	
		Mean value of $\frac{\text{M.R.}_{calc} - \text{M.R.}_{obs}}{\text{M.R.}_{obs}} \times 100$	Standard deviation	Mean value of $\frac{\text{M.V.}_{calc} - \text{M.V.}_{obs}}{\text{M.V.}_{obs}} \times 100$	Standard deviation
n-Paraffins	9	+0·012	0·056	−0·02	0·07
br-Paraffins	37	+0·19	0·26	+0·31	0·80
Monocyclic saturates	26	−0·01	0·20	+0·10	0·33
Fused-ring saturates	19	−0·008	0·26	+0·66	0·80
Monocyclic aromatics	19	+0·26	0·18	+0·03	0·19
Fused-ring aromatics	8	+0·17	0·64	−0·46	0·89

These data are tabulated in Table VI and represented graphically in Fig 10.

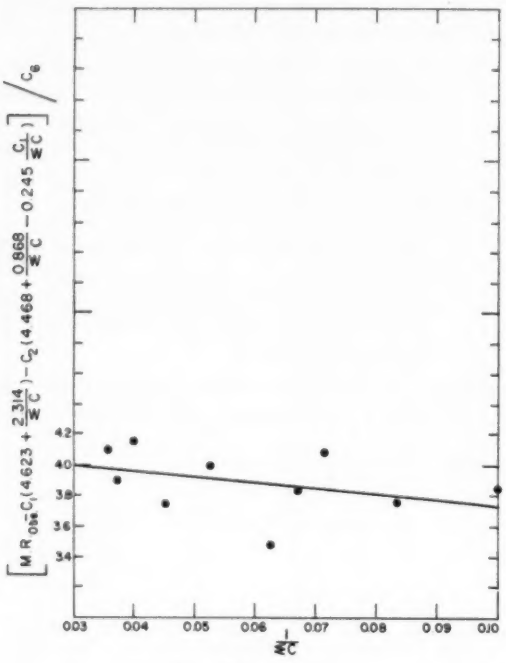

FIG 10

DETERMINATION OF r_6 AND h_6

TABLE VI

Data for the Determination of r_6 and h_6

API 42 Compound No.	$\frac{M.R_{obs}-C_1\left(4.623+\frac{2.314}{\Sigma C}\right)-C_2\left(4.468+\frac{0.868}{\Sigma C}-0.245\frac{C_1}{\Sigma C}\right)}{C_6}$	$1/\Sigma C$
551	3·840	0·1
548	3·841	0·067
580	3·764	0·083
520	4·087	0·071
564	3·483	0·0625
505	3·978	0·0526
553	3·745	0·0454
19	4·161	0·040
199	3·898	0·037
172	4·092	0·0357

The least squares equation of the straight line in Fig 10 was

$$\left[\frac{M.R_{obs}-C_1\left(4.623+\frac{2.314}{\Sigma C}\right)-C_2\left(4.468+\frac{0.868}{\Sigma C}-0.245\frac{C_1}{\Sigma C}\right)}{C_6}\right]=4.105-\frac{3.634}{\Sigma C} \quad (20)$$

i.e. $r_6 = 4.105$ and $h_6 = -3.634$.

Rearranging equation (20), the molar refraction of non-fused naphthenes could be represented by the following equation:

$$M.R. = C_1\left(4.623+\frac{2.314}{\Sigma C}\right)+C_2\left(4.468+\frac{0.868}{\Sigma C}-0.245\frac{C_1}{\Sigma C}\right)+C_6\left(4.105-\frac{3.634}{\Sigma C}\right) \quad (21)$$

Equation (21) was then used to calculate the molar refraction of 21 non-fused naphthenes on the API 42 list. The mean value of the quantity

$$\frac{M.R._{calc}-M.R._{obs}}{M.R._{obs}}\times 100$$

was determined to be +0·07 and the standard deviation from the mean was 0·53 per cent.

Determination of r_7 and h_7

In studying the molar volume [3] of hydrocarbons containing C_7 groups, it was found that the C_2 correction on the C_4 term was not applicable to non-fused hydrocarbons. Since the molar volume and the molar refraction are intimately related, it was assumed that this C_2 correction on the C_4 term would likewise not be applicable for the molar refraction.

TABLE VII

Data for the Determination of r_7 and h_7

API 42 Compound No.	$\frac{(M.R._{obs}-M.R._{C_1}-M.R._{C_2}-M.R._{C_6}-M.R._{C_4})}{C_7}$	$1/\Sigma C$
521	3·43	0·071
522	3·35	0·071
517	3·33	0·071
128	2·62	0·040
130	2·75	0·040
126	2·77	0·040
519	2·99	0·071
516	3·15	0·071
503	3·37	0·053
18	3·32	0·040
89	2·77	0·040
12	3·51	0·038
116	3·86	0·038
171	2·88	0·036

The quantities r_7 and h_7 were determined by the same method as used for r_6 and h_6. 14 non-fused API 42 aromatics were used for this purpose. The following quantity,

$$\left[\frac{M.R._{obs}-C_1\left(4.623+\frac{2.314}{\Sigma C}\right)-C_2\left(4.468+\frac{0.868}{\Sigma C}-0.245\frac{C_1}{\Sigma C}\right)-C_6\left(4.105-\frac{3.634}{\Sigma C}\right)-C_4\left(4.5445-\frac{1.021}{\Sigma C}-0.396\frac{C_1}{\Sigma C}\right)}{C_7}\right]$$

which represented the C_7 molar refraction increment, was calculated for each of these 14 hydrocarbons, omitting the C_2 correction on the C_4 term, as has already been mentioned. These data are tabulated in Table VII.

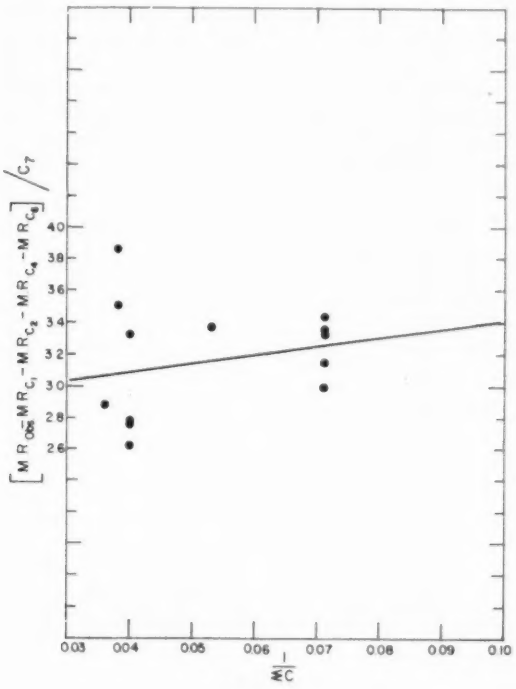

FIG 11

DETERMINATION OF r_7 AND h_7

These data are also presented graphically in Fig 11. The least squares straight line through these points was calculated and found to be:

$$\frac{M.R_{obs} - M.R_{C_1} - M.R_{C_2} - M.R_{C_4} - M.R_{C_6}}{C_7} = 5{\cdot}405\,1/\Sigma C + 2{\cdot}872 \quad (22)$$

Equation (22) was rearranged to give the following molar refraction equation for non-fused saturated and aromatic hydrocarbons:

$$\begin{aligned} M.R. = {} & C_1\left(4{\cdot}623 + \frac{2{\cdot}314}{\Sigma C}\right) \\ & + C_2\left(4{\cdot}468 + \frac{0{\cdot}868}{\Sigma C} - 0{\cdot}245\frac{C_1}{\Sigma C}\right) \\ & + C_4\left(4{\cdot}5445 - \frac{1{\cdot}021}{\Sigma C} - 0{\cdot}396\frac{C_1}{\Sigma C}\right) \\ & + C_6\left(4{\cdot}105 - \frac{3{\cdot}634}{\Sigma C}\right) + C_7\left(2{\cdot}872 + \frac{5{\cdot}405}{\Sigma C}\right) \end{aligned}$$

The accuracy with which this equation predicted the molar refraction of these 14 compounds was calculated. The mean value of

$$\frac{M.R_{calc} - M.R_{obs}}{M.R_{obs}} \times 100$$

was found to be +0·028 and the standard deviation from the mean was determined to be 0·62.

DISCUSSION

Equation (18) has been used, along with four additional property equations, in a method of structural analysis which has been reported elsewhere.[19] This method consisted of the simultaneous solution of five equations. The accuracy with which equation (18) represented the molar refraction of the API 42 hydrocarbons was found to be adequate for using the equation in this method of analysis to determine the average number of structural groups to within one carbon atom. The detailed description of this equation has been given to illustrate that it is possible to express the molar refraction in an identical form to that used for the molar volume. This is a considerable convenience, from a mathematical point of view, in the simultaneous solution of the five equations. As with the corresponding molar volume equation, the form of the equation is such that the molar refraction increment for each structural group is apparent by inspection $\left(r_i + \frac{h_i}{\Sigma C}\right)$. In this form, r_i represents the limiting value of the coefficient as ΣC is increased.

In certain cases (C_3, C_5, C_6, and C_7), where it was not possible to obtain data for compounds containing only one of each of these types, the coefficients were, of course, not characteristic values associated with one species only, as was the case for C_1, C_2, and C_4. The coefficient C_3 contained the interaction effects of C_2 and C_3, while that of C_5 contained the interaction effects of C_4 and C_5. The coefficients of C_6 and C_7 included the effects of C_1 and C_2 with C_6; and C_1, C_4, C_2, and C_6, with C_7. This placed a limitation on the amount of structural information which could be obtained concerning polycyclic compounds. However, the manner in which these coefficients were determined readily permits the re-determination of the C_3, C_5, C_6, and C_7 coefficients as properties become available on compounds containing increasing proportions of each of these groups.

Table V presents the accuracy with which equation (18) expressed the molar refraction of the API 42 hydrocarbons. For comparison, the accuracy of the corresponding molar volume equation has been included. In developing the molar refraction equation, it was decided to attempt to attain approximately the same order of accuracy as had been obtained in the case of the molar volume equation, since no equation existed for the molar refraction of the same general

type with which to compare the present equation. The two equations are of the same form and the accuracies are similar within each structural type. However, attention is drawn to several points of interest. The molar refraction equation was more accurate than the molar volume equation for the monocyclic saturates, fused-ring saturates, and fused-ring aromatics. For the saturated hydrocarbons, this improved accuracy is due, almost certainly, to the interaction term of C_1 on C_2 which was included in the molar refraction equation but not in the molar volume equation. For the fused-ring aromatics, the added accuracy in the molar refraction equation was probably due to the more reliable experimental data used. When the C_5 coefficients were determined in the molar volume equation, no liquid state data were available for fused-ring aromatics, and such data were calculated from solid state data by a method reported in detail elsewhere.[3] However, experimental molar refraction data, based on solution measurements, were available that were more reliable than the "hypothetical" molar volume properties used. The molar

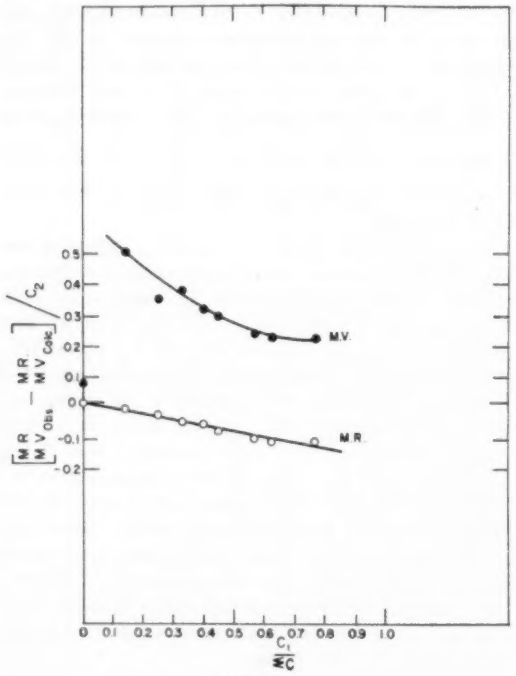

FIG 12

COMPARISON BETWEEN THE MOLAR REFRACTION AND THE MOLAR VOLUME OF THE INTERACTION EFFECT BETWEEN C_1 AND C_2

refraction equation was less accurate than the molar volume equation for the monocyclic aromatics. However, it should be noted that the deviation from the mean is almost identical with that for the molar volume equation for this group.

By studying the differences between the calculated and observed molar refractions for the branched paraffins, information can be obtained concerning the effect of branching. Table IV presents the detailed results of calculating the molar refraction of the API

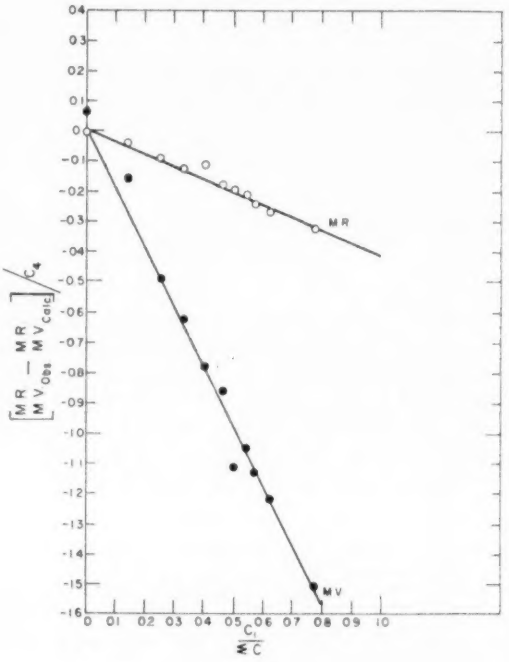

FIG 13

COMPARISON BETWEEN THE MOLAR REFRACTION AND THE MOLAR VOLUME OF THE INTERACTION EFFECT BETWEEN C_1 AND C_4

42 hydrocarbons. The differences between calculated and observed values are also tabulated. By inspection, it was apparent that this difference increased as the number of branches increased. Insufficient data were available to determine this relationship with precision. However, it would appear that when this difference exceeded +0·12 more than one branch would be present. It should be pointed out that this effect is somewhat nullified by an increase in molecular weight. Beyond a molar refraction of about 125, the values of ($M.R._{calc} - M.R._{obs}$) approached zero and then became slightly negative. When the coefficients r_1 and h_1 were determined, both for the normal and the branched paraffins, it was found that r_1 was higher and h_1 smaller for the branched paraffins than for the normal paraffins.

In Figs 12–14 a comparison has been made between the molar volume and the molar refraction of the interaction effects that have been studied. Fig 12 consists of the graph given in Fig 7, the interaction effect of C_1 on C_2 for the molar refraction

$[(M.R_{\cdot obs} - M.R_{\cdot calc})/C_2$ *v.* $C_1/\Sigma C]$, and also contains the corresponding plot for the molar volume $[(M.V_{\cdot obs} - M.V_{\cdot calc})/C_2$ *v.* $C_1/\Sigma C]$ based on the same compounds, all plotted on the same scale. These two curves appear to be parallel. The effect of adding a single C_1 group to a saturated ring produced opposing effects in the two properties. The magnitude of the effect is very much greater for the molar volume than for the molar refraction. When C_1 groups are added to a saturated ring the molar refraction is depressed and the molar volume increased, as compared with the values which would be calculated from the equation without its interaction effects. It should be noted

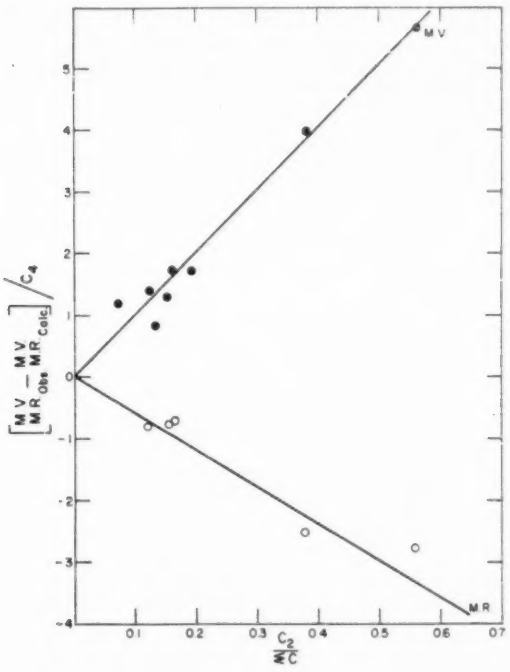

FIG 14

COMPARISON BETWEEN THE MOLAR REFRACTION AND THE MOLAR VOLUME OF THE INTERACTION EFFECT OF C_2 IN FUSED-RING AROMATICS

that the molar volume curve did not pass through the origin. This is a distinct limitation when calculating the C_1 on C_2 interaction term for the molar volume. It has not been necessary, as yet, to use this term in the molar volume equation, since its magnitude is comparatively small and the additional accuracy is not required for the present purpose.

Fig 13 contains the corresponding pair of curves expressing the interaction effects of C_1 and C_4. Here the effect for both the molar volume and the molar refraction can be expressed by a straight line passing through the origin. Both lines have a negative slope. Consequently, both properties are depressed by the addition of C_1 to an aromatic ring. The magnitude of the effect is about five times larger for the molar volume than for the molar refraction.

Fig 14 illustrates the corresponding comparison for the interaction effect of C_2 on C_4. Here again, both properties yield a straight-line relationship passing through the origin. However, in this case the effect is opposite in sign: positive for the molar volume, and negative for the molar refraction. The magnitude of the effect in the molar volume is about twice as great as for the molar refraction.

The work on non-fused hydrocarbons is still in its preliminary stages. It was possible to treat this group of compounds in a manner analogous to that used to derive the molar volume expression for this group. The values obtained for the r and h for both C_6 and C_7 indicated them to be distinct structural types. As in the development of the molar volume expression, the C_2 interaction effect on the C_4 term was not found applicable to the non-fused hydrocarbons. Due to lack of available data, these coefficients for the non-fused hydrocarbons were based on compounds containing C_1, C_2, and C_6 and C_1, C_2, C_6, C_4, and C_7 groups, respectively. It is anticipated that, to obtain a more accurate equation for non-fused hydrocarbons, the constants will have to be revised by studying compounds containing increasing proportions of C_6 and C_7 groups respectively, as these become available, especially in the absence of C_1 groups. The effect of the interaction of C_1 groups on C_6 and C_7 groups could then be examined in detail. The study of hydrocarbons containing both fused and non-fused rings will have to await the accumulation of suitable data.

CONCLUSION

An equation has been developed which expresses the molar refraction of 118 API 42 pure hydrocarbons in terms of five structural groups (equation (18)). This equation is of the same functional form as that previously obtained for the molecular volume. The overall accuracy and the accuracy within each structural type are of the same order as the molar volume equation, and this permits these two equations to be solved simultaneously with three other relations to obtain structural information. This equation is applicable to linear and branched hydrocarbons, including fused polycyclic hydrocarbons, whether saturated or aromatic. While this equation does not include compounds containing non-fused rings, two additional equations, (21) and (23), have been developed to express the molar refraction of saturated non-fused polycyclic compounds (equation (21)) and of compounds which contain both saturated and aromatic non-fused rings (equation (23)).

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VARIATION OF FLUID PROPERTIES WITH ELEVATION IN HIGH-RELIEF OIL RESERVOIRS *

By J. G. ROOF †

SUMMARY

Several examples are known of high-relief oil reservoirs in which fluid properties vary appreciably with elevation. The literature contains a few references to the significance of these variations in material-balance computations of oil-in-place.

In this paper some reports on properties in high-relief oilfields are reviewed briefly. It is doubtful that thermodynamic and compositional equilibrium exists in all cases, and it is apparent that no "typical" variation with elevation is applicable to the several fields.

A theoretical study is made of the distribution of components in a binary hydrocarbon system in the liquid state when the system is placed in the gravitational field in an average geothermal gradient. Volumetric data and recently acquired thermal-diffusion data permit computations which show that the gravitational segregation and the geothermal segregation are opposite in sign and are essentially equal in magnitude for the methane–butane system at its bubble point under the specified conditions of composition, pressure, and temperature gradient. Further, it is seen that these mixtures are unstable towards convective mixing, the efficacy of which is known to be influenced by such factors as permeability and thickness of the formation.

Results of computations for this binary system are not directly applicable to the complex mixtures found in oil. However, it is probable that in natural mixtures in the single phase the effects of gravity and of the geothermal gradient are opposite in sign and that the tendency for the light constituents to concentrate in the upper portion of the formation will be less than had once been supposed.

SYMBOLS

Symbol	Name	Units
p	pressure	psi
p_b	pressure, bubble point	psi
R	dissolved gas–oil ratio	cu ft/brl
t	temperature	°F
T	temperature	°R
v	volume, specific	cu ft/lb
v_1, v_2	volume, partial specific	cu ft/lb
w_1, w_2	weight fraction	—
z	elevation	100 ft
α	thermal diffusion factor	—
μ_1, μ_2	chemical potential	ft-lb/lb
ρ	density	lb/cu ft
Subscripts		
adiab	adiabatic	
geo	geothermal	
grav	gravitational	
ther	thermal diffusion	
b	at bubble point	
o	at original elevation	
p	at constant pressure	
t	at constant temperature	
w_1	at constant composition	
z	at elevation z	

INTRODUCTION

THE composition and physical properties of fluids in an oil reservoir may vary with the elevation, and several examples of this have been reported in the literature during the past decade. When such variation exists, material-balance calculations on a high-relief reservoir may be in error if the reservoir is treated as a whole with averaged values of the pertinent fluid parameters. Recently, Grant [1] made a study of a hypothetical reservoir with 1000 feet closure in which the parameters were certain assumed functions of the elevation above a datum. He applied material-balance computations to horizontal layers, each with its own p–v–t characteristics, and demonstrated that use of average p–v–t properties for the whole of this reservoir with its assumed properties does result in quite substantial errors.

Although Grant's handling of the computations for his assumed reservoir is consistent with material-balance methods, questions arise concerning certain assumptions made on the variation of properties with elevation. Two cited references [2,3] led to the assumption that the tank oil gravity increased upward at the rate of 0·7° API/100 ft; one reference [4] was cited for the assumption that the bubble-point pressure increased at an average of 70 psi/100 ft, which was said to be similar to variations found in Kuwait. An examination of these and other data may show that such variations are not necessarily typical and that some of the data appear to be questionable.

The purpose of this paper is two-fold: first, to examine certain available data on variation of fluid properties with elevation in oil reservoirs to determine whether a "typical" variation occurs, and secondly, to present a theoretical consideration of equilibrium in vertical columns of fluids in the geothermal gradient.

FIELD DATA

This section contains a review of certain data to which Grant referred and information on two additional fields.

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Bolivar Coastal Field

The paper by McCord [2] on the LL-370 area of this field in Venezuela includes data that led to the use [1] of 0·7° API/100 ft as the rate of change of oil gravity with elevation. The data raise some questions. For example, the bubble-point pressure is shown to *decrease* with increasing elevation at the rate of about −16 psi/100 ft. This is to be contrasted with the *increase* of 70 psi/100 ft used by Grant. However, doubt exists about the meaning of some of the Bolivar Coastal data. Since the bubble-point pressure depends only on the separator gas–oil ratio * and the temperature, one may write †

$$\frac{dp_b}{dz} = \left(\frac{\partial p_b}{\partial t}\right)_R \frac{dt}{dz} + \left(\frac{\partial p_b}{\partial R}\right)_t \frac{dR}{dz} \quad . \quad (1)$$

This equation involves five derivatives, values for three of which are available from the report:

$$dt/dz = -1{\cdot}6^\circ \text{ F}/100 \text{ ft}$$
$$dp_b/dz = -16 \text{ psi}/100 \text{ ft}$$
$$dR/dz = +21 \text{ (cu ft/brl)}/100 \text{ ft}$$

For oils with p_b around 2000–2500 psi at 180° F, correlations by Standing [5] or Lasater [6] give $(\partial p_b/\partial t)_R =$ 4·5 or 3·9, respectively. Insertion of these four values into equation (1) leads to $(\partial p_b/\partial R)_t = -0{\cdot}42$ or $-0{\cdot}46$.

The negative sign for $(\partial p_b/\partial R)$ is not given by Standing's or Lasater's correlations; it has not been observed in any of the considerable number of natural systems studied by the author, and does not occur in any of the reported systems with which the author is familiar. If all other derivatives are correct $(\partial p_b/\partial t)_R$ would have to become greater than 10 to permit $(\partial p_b/\partial R)_t$ to become positive.

Newhall–Potrero Field

The brief article [3] on the Fifth Zone in this field gives insufficient quantitative information to determine the rates of change of the several properties with elevation. It appears that the produced tank oil gravity varies 14° API over a vertical interval of some 2000 to 2959 feet. It should be noted that "the average thickness of net effective saturated oil sand . . . represents little more than half of the total thickness of the sand interval. Numerous interbedded shales, siltstones, and cemented sandstone shell account for the remainder of the barren section." It may be difficult to assess quantitatively the rate of variation of fluid properties in a very steeply dipping, non-homogeneous reservoir.

Rangely Field

Of the Weber sandstone in the Rangely field,[4] "it has been estimated that 30 per cent of the upper 550 feet would represent, conservatively, the effective oil sand. Field-wide correlations of productive zones have not been possible . . ."

Probably the most important factor to note at this time is that at the greater depths the properties of the fluids tend to become less dependent upon depth. This is the opposite of the trends that Grant used and may tend to minimize some of the differences between his computations on the reservoir as layers and as a single body with average p–v–t properties.

"The oil-characteristic data developed during this investigation have been used by engineers of several of the operating companies in exhaustive studies of the Weber reservoir. In these studies use is made of the data indicating variance of oil characteristics with elevation in the reservoir so that actual reservoir conditions could be described through material-balance calculations." [4]

Elk Basin Field

A study of the Tensleep sandstone in the Elk Basin field [7, 8] also showed variation of properties of the oil with elevation. The closure in this field is estimated to be 5000 to 10,000 feet, and the top 2000 feet of the structure contained oil at discovery. For present purposes it is probably sufficient to note that increase of 1700 feet in elevation caused the gas–oil ratio to increase from 134 to 490 cu ft/brl and the bubble-point pressure to rise from 530 to 1250 psi, even though there was a decrease of about 29° F in the formation temperature over this interval. Actually, the properties of the fluid in the upper 600 feet are essentially constant, and most of the variations occurred in the lower 1100 feet at rates almost independent of depth.

Scurry Reef Field

A report [9] indicates "that there is a trend in the form of gravitational concentration gradients (a progressive decrease in mole fraction of the gases from methane through the butanes with increasing depth in the reservoir . . .)" in the northern part of this field. Data indicate that over this large, low-relief field the average value of dR/dz is about 45 (cu ft/brl)/100 ft. There is evidence "that equilibrium or a near state of equilibrium conditions have not been established in the reservoir fluid."

La Paz Field

This field in Venezuela produces from limestone with an average thickness of nearly 2000 feet with an original oil column of over 7000 feet. Pertinent data [10] on three samples are presented in Table I. The bubble-point pressures for these three samples at

* This is strictly true if there is no change in composition of the gas and of the oil, only the ratio being allowed to vary.

† See table of symbols and units at beginning of text. Note that the unit of elevation is chosen as 100 feet rather than one foot.

various temperatures are plotted in Fig 1. There is a remarkable agreement among these data, the greatest difference being somewhat less than 10 psi.

TABLE I

Producing Formation in Three Wells in La Paz Field

Well	Producing formation		
	Depth to top (ft, subsea)	Thickness (ft)	Interval open to production (ft, subsea)
A	5519	2057	5535–7588
B	7808	650 *	7823–8458
C	7528	2006	7595–9535

* Thickness penetrated, 650 feet. Estimated thickness, 1950 feet.

The table shows considerable difference in elevation in the interval open to production in these three wells, *A* being above the other two. On the basis of bubble-point pressure, these wells would appear to be producing fluid of the same composition. One is

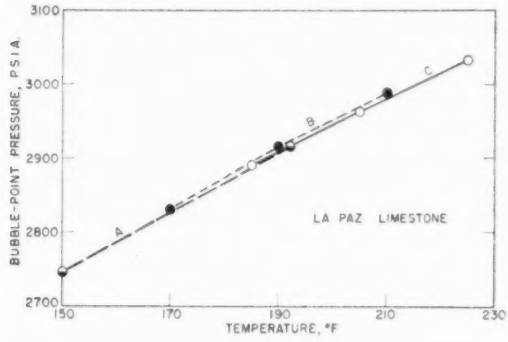

FIG 1

BUBBLE-POINT PRESSURE AS FUNCTION OF TEMPERATURE FOR LA PAZ FIELD, VENEZUELA [10]

inclined to assume constant composition within the oil column; *i.e.* $dR/dz = 0$. The data indicate $dp_b/dt = 4$, which, when used in equation (1) with the observed low value of $dt/dz = -1{\cdot}0$, gives $dp_b/dz = -4$. The sign of this derivative is opposite to that used by Grant and reported for Rangely [4] and Elk Basin.[7]

Summary of Field Data

Although some fields show variation of composition with elevation within an oil column, not all exhibit such behaviour. Each field must be examined individually to determine how the properties vary and whether the variation is sufficiently great to justify attempts at material balance on separate horizontal layers.

Rates of variation assumed by Grant for a field 1000 feet thick when extrapolated even linearly to greater depths lead to results that are difficult to interpret. Grant's Fig 3 extrapolates linearly to zero gas–oil ratio at a depth of about 1450 feet below cap rock, and Fig 5 extrapolates linearly to zero bubble-point pressure at a depth of about 1800 feet below cap rock. It is evident that Figs 3 and 5 need to be modified if a reservoir considerably thicker than 1000 feet is being considered.

THEORETICAL

Because of wide differences in the reported properties in several reservoirs, an attempt has been made to study the vertical variation of fluid properties from a thermodynamic approach.

For a homogeneous, single-phase fluid mixture of two or more components the value of an intrinsic property, such as density or viscosity, depends on three variables: pressure, temperature, and composition. Not only do pressure and temperature vary with elevation in a fluid phase in an oil or gas reservoir, but also columns of single-phase fluid mixtures are subject to vertical gradients of composition. The thermodynamics of an isothermal fluid mixture was considered by Gibbs.[11]

The change with elevation of density, for example, of a binary fluid mixture is given by the general equation

$$\frac{d\rho}{dz} = \left(\frac{\partial \rho}{\partial p}\right)_{t,w_1} \frac{dp}{dz} + \left(\frac{\partial \rho}{\partial t}\right)_{p,w_1} \frac{dt}{dz} + \left(\frac{\partial \rho}{\partial w_1}\right)_{p,t} \frac{dw_1}{dz} \quad (2)$$

Since $dp/dz = -\rho g$, equation (2) becomes

$$\frac{d\rho}{dz} = -\rho g \left(\frac{\partial \rho}{\partial p}\right)_{t,w_1} + \left(\frac{\partial \rho}{\partial t}\right)_{p,w_1} \frac{dt}{dz} + \left(\frac{\partial \rho}{\partial w_1}\right)_{p,t} \frac{dw_1}{dz} \quad (3)$$

All terms required to calculate $d\rho/dz$ are subject to direct measurement in the laboratory, with the exception of two: dt/dz is measured in the given reservoir and dw_1/dz is calculated from volumetric and thermal-diffusion data.

Let us first consider the special case of an isothermal column of fluid. Here dt/dz is zero, and data for the calculation of dw_1/dz are more likely to be available.

Isothermal Case

The results of Gibbs's approach [11] to the isothermal case lead to an expression of the following type when the composition of the binary mixture is expressed in terms of weight fractions: *

$$\frac{dw_1}{dz} \equiv \left(\frac{dw_1}{dz}\right)_{grav} = \frac{w_2(v_1 - v_2)g}{v\left(\frac{\partial \mu_1}{\partial w_1}\right)_{p,t}} \quad . \quad (4)$$

* When common English units are used, as in this paper, g should not appear in equations (4) and (5).

Application of this equation to ideal solutions requires only composition and molal volumes of the two constituents. Sage and Lacey [12] have shown how small the compositional changes with elevation are for ideal gaseous and liquid mixtures of methane and butane. However, the assumption of ideality of solutions is not justified at elevated pressures and temperatures, especially as the critical region of the mixture is approached. Subsequent work by Sage and Lacey [13,14] presents partial-volume data on the same system which, through appropriate graphical procedures, permit calculation of fugacity and thus values of the chemical potential in this non-ideal system. In principle, then, it is possible to calculate the rate of change of composition with elevation in isothermal methane–butane mixtures. In practice, the values of $(\partial\mu_1/\partial w_1)_{p,t}$ are so sensitive to small experimental errors in the volumetric measurements that it is desirable to use an equation of state to determine this partial derivative, although the experimental values of the partial specific volumes may be used directly in the equation for dw_1/dz.

General Case

The general case allows the inclusion of a thermal gradient in considering the variation of composition and physical properties with elevation. Partial demixing of a fluid mixture in the presence of a thermal gradient—the Soret effect—has been recognized for over a century. Quantitative measurements of the extent of demixing and application of these data to other problems have been possible only more recently. Use of steady-state thermodynamics permits setting up an expression for variation of composition with elevation in a vertical column of fluid in a geothermal gradient. By pursuing the line of development set forth by de Groot [15] one can derive the general expression for the problem under consideration:

$$\frac{dw_1}{dz} = \left(\frac{dw_1}{dz}\right)_{\text{grav}} + \left(\frac{dw_1}{dz}\right)_{\text{ther}} = \frac{w_2(v_1 - v_2)g}{v\left(\frac{\partial\mu_1}{\partial w_1}\right)_{p,t}} + \frac{\alpha w_1 w_2}{T}\frac{dT}{dz} \quad . \quad (5)$$

Thus, according to steady-state thermodynamics, the effect of a vertical temperature gradient is an additional term in the expression for dw_1/dz. The thermal-diffusion factor α is a measure of the extent of the partial demixing. It cannot yet be predicted with sufficient accuracy, and must therefore be determined experimentally under the desired conditions of pressure, temperature, and composition.

Implications of the Theory

When partial-volume data and thermal-diffusion data are inserted into equation (5), a numerical value of dw_1/dz is made available for use in the general equation (3). This equation also requires laboratory information on the variation of the given property, *e.g.* density, with pressure, temperature, and composition.

Although equation (3) generally applies for most of the intensive properties of the mixture, there is one property of interest to the reservoir engineer that obeys a more restricted relationship. The bubble-point pressure of a liquid (or, similarly, the dew-point pressure of a gas) is subject to a restraint that removes one term from equation (3). For a liquid to be at its bubble point, its vapour pressure must be equal to the applied pressure. Since bubble-point pressure is a function of temperature and composition only, we have the restricted equation

$$\frac{dp_b}{dz} = \left(\frac{\partial p_b}{\partial t}\right)_{w_1}\frac{dt}{dz} + \left(\frac{\partial p_b}{\partial w_1}\right)_t\frac{dw_1}{dz} \quad . \quad (6)$$

In considering the manner in which the bubble-point pressure may vary vertically in a reservoir, one recognizes the presence of a geothermal gradient and a non-vanishing value for dt/dz. However, it is conceivable that dw_1/dz may be zero because of the effect of either of two factors: (1) the possibility that the two terms in equation (5) may be equal and of opposite signs, or (2) the existence of a sufficiently vigorous convection within the fluid to prevent setting up a stable composition gradient.

If, for either of these reasons, the composition is constant throughout a given reservoir, equation (6) simplifies to

$$\frac{dp_b}{dz} = \left(\frac{\partial p_b}{\partial t}\right)_{w_1}\frac{dt}{dz} \quad . \quad . \quad . \quad (7)$$

In this special case the determination of variation of bubble-point pressure with depth requires only the geothermal gradient and laboratory observations on a change in bubble-point pressure with temperature on a sample of constant composition. Since z increases upward, the thermal gradient has a negative sign. Generally, $(\partial p_b/\partial t)_{w_1}$ has a positive sign, which leads to the conclusion that, if the composition of a fluid is independent of elevation, the bubble-point pressure decreases with increasing elevation in the reservoir. However, this conclusion is not without exceptions, since occasionally a reservoir system is found for which the bubble-point pressure decreases with increasing temperature. Several deep wells in Louisiana produce fluids which behave in this manner.

Methane–Butane System

The theory outlined above permits calculation of changes in composition and in bubble-point pressure with elevation in a binary fluid system. These calculations are possible for the methane–butane

system since adequate volumetric data [13,14] and thermal-diffusion data [16] are now available. As mentioned above, the derivative $(\partial\mu_1/\partial w_1)$ is best calculated from an equation of state; the Benedict–Webb–Rubin equation for mixtures [17] is used here. The thermal-diffusion data cover only two compositions, $w_1 = 0{\cdot}1554$ and $0{\cdot}2096$. The geothermal gradient chosen was $-1{\cdot}8°$ F/100 ft, the mean given by Van Orstrand.[18] Table II includes values of the relevant factors used in the calculations for these two compositions at 160° F.

TABLE II

Computations for Methane–Butane System

w_1	0·1554	0·2096	—
$(\partial\mu_1/\partial w_1)_{p,t}$	$13{\cdot}4 \times 10^4$	$5{\cdot}31 \times 10^4$	(ft-lb) (lb)$^{-1}$
α	6·5	9·8	—
$(dw_1/dz)_{grav}$	$1{\cdot}82 \times 10^{-3}$	$4{\cdot}75 \times 10^{-3}$	(100 ft)$^{-1}$
$(dw_1/dz)_{ther}$	$-2{\cdot}51 \times 10^{-3}$	$-4{\cdot}72 \times 10^{-3}$	(100 ft)$^{-1}$
dw_1/dz	$-0{\cdot}69 \times 10^{-3}$	$+0{\cdot}03 \times 10^{-3}$	(100 ft)$^{-1}$
dp_b/dz	−7·0	−0·7	(psi) (100 ft)$^{-1}$

It is evident that neither the demixing due to gravity nor that due to thermal diffusion is very large. It is significant that the tendencies are in opposite directions. The lighter methane molecules tend to rise because of their being less dense, but they are drawn toward the hotter lower regions of the reservoir. For these two compositions in the methane–butane system for which calculations can now be made, the gravitational and thermal-diffusion effects essentially offset each other. The net change in composition with elevation is very small in each case. Expressed as per cent increase in weight fraction of methane per 100 feet rise in elevation, the changes are only about $-0{\cdot}07$ and $+0{\cdot}003$ per cent for $w_1 = 0{\cdot}1554$ and $0{\cdot}2096$, respectively. The relative importance of the two terms in equation (5) depends on the value of the geothermal gradient dt/dz, which has been reported to vary by as much as a factor of 10.

The change in bubble-point pressure with elevation in these examples is calculated to be $-7{\cdot}0$ and $-0{\cdot}7$ psi/100 ft for the two compositions, respectively. In comparison with field data these calculations are consistent in sign with the La Paz results and are opposite to those from the other examples cited.

Convection

Whenever a fluid is in an environment in which the temperature decreases in the upward direction, the question of convection arises. A criterion for instability of a fluid to convection is as follows: A mass of the fluid at rest at given temperature, pressure, and composition has a certain density, which is equal to that of the surrounding fluid at the same level. This mass of fluid is lifted to some higher level; the pressure on the fluid is allowed to become equal to that at the new level; the temperature has then changed in some manner because of the pressure change and any heat flow. The process may be essentially adiabatic in the sea or in the atmosphere, but is more generally non-adiabatic. Since pressure and temperature are changed, the density of the fluid in its new environment has also changed. If its new density ρ^* is greater than ρ_z of the fluid now surrounding it, this transported fluid will tend to move back to its original level, and the system is stable. If $\rho^* < \rho_z$, the lifted fluid will tend to move on upward, and the system is unstable to convection.

In general, the theory and the experimental work on convection in porous media leave several questions unanswered. (A brief discussion and a bibliography are given in Ref 19.) However, in the examples given above for the methane–butane system, conclusions about the tendency towards convection are possible.

Imagine, for a first case, the heat capacity and conductivity of the porous medium to be so great that the lifted liquid is subject to the geothermal gradient and immediately assumes the temperature of the new level. Then the density of the lifted liquid becomes

$$\rho^*_{geo} = \rho_o + \Delta z\left[\left(\frac{\partial\rho}{\partial p}\right)\frac{dp}{dz} + \left(\frac{\partial\rho}{\partial t}\right)\left(\frac{dt}{dz}\right)_{geo} + \left(\frac{\partial\rho}{\partial w_1}\right).0\right] \quad . \quad (8)$$

whereas

$$\rho_z = \rho_o + \Delta z\left[\left(\frac{\partial\rho}{\partial p}\right)\frac{dp}{dz} + \left(\frac{\partial\rho}{\partial t}\right)\left(\frac{dt}{dz}\right)_{geo} + \left(\frac{\partial\rho}{\partial w_1}\right)\frac{dw_1}{dz}\right] \quad . \quad (9)$$

Whence

$$\rho_z - \rho^*_{geo} = \Delta z\left[\left(\frac{\partial\rho}{\partial w_1}\right)\frac{dw_1}{dz}\right] \quad . \quad (10)$$

For the methane–butane examples given above $(\partial\rho/\partial w_1)$ is negative; dw_1/dz is also negative if the geothermal gradient is steeper than $-1{\cdot}32°$ and $-1{\cdot}82°$ F/100 ft, respectively. So

$$\rho_z - \rho^*_{geo} = +\,[(-)\cdot(-)] = +\ . \quad (11)$$

or

$$\rho^*_{geo} < \rho_z$$

Thus, if the temperature of the lifted liquid is made to assume the value of its surroundings, this system of given composition and under the indicated geothermal gradients is unstable to convection.

For a second example, the adiabatic process may be considered. It is assumed that no heat is allowed

to flow into or out of the lifted liquid. From the equation

$$\frac{c_p}{T}\left(\frac{dT}{dz}\right)_{\text{adiab}} = \left(\frac{\partial v}{\partial T}\right)_p \frac{dp}{dz} \quad . \quad . \quad (12)$$

one can estimate the rate of fall in temperature as the liquid is lifted adiabatically.[20]

Although heat capacity data are not available for the methane–butane system, data for several liquid substances have been reported. From specific heat[21] and volumetric[22] data for butane at 160° F and 500 psi, the value of $(dt/dz)_{\text{adiab}}$ is calculated to be approximately −0·17° F/100 ft, which is only one-tenth of the geothermal gradient. If the rate of temperature drop with increase in elevation for the mixtures is only a fraction of the geothermal case, it follows that

$$\rho^*_{\text{adiab}} < \rho^*_{\text{geo}} < \rho_z$$

and that the instability to convection is even greater than for the geothermal case. The proper dt/dz falls between that of the geothermal case and that of the adiabatic case. Therefore the system is unstable to convection in the examples given.

Instability to convection does not necessarily ensure that vigorous mixing will be established in a porous medium. Such factors as permeability and thickness of the formation are critical. However, it is significant that in these examples from the methane–butane system the composition gradient is such that there is instability to convection.

Although results of computations for a binary system are not immediately applicable to complex mixtures, it is likely that in natural, single-phase hydrocarbon mixtures the effect of gravity and of the geothermal gradient will be of opposite sign. Thus the tendency of the lighter hydrocarbons to concentrate in the upper portion of the formation will be less than would be the case in an isothermal environment.

SUMMARY AND CONCLUSIONS

There is no doubt that in some oil reservoirs the composition and related properties vary with the elevation within the porous medium. However, not all reservoirs of great thickness show the same amount of variation; in fact, at least one major reservoir appears to be of uniform composition over a vertical distance of some 2000 to 4000 feet.

Calculations on a binary hydrocarbon system for which partial-volume data (for gravitational segregation) and thermal-diffusion data (for geothermal separation) are available indicate that these two separation tendencies are opposed and, under the given conditions, essentially cancel each other. These mixtures are shown to be unstable to convection in typical geothermal gradients.

When the composition is essentially constant over the reservoir, the question of convection need not be considered. If, however, the net result of the opposing gravitational and thermal segregations leads to a distribution which is unstable to convection, convection currents may be set up to cause mixing and to tend to bring the mixture towards uniform composition. Interbedded impermeable strata in a reservoir prevent convection or other vertical flow of constituents and can prevent establishment of either the stationary state or of complete mixing.

When large variations of properties with elevation occur, compositional equilibrium is questionable. It is suggested that low-permeability barriers exist, that inadequate time has elapsed to achieve equilibrium, or that some phenomenon is causing compositional changes in a portion of the reservoir. The latter could, for example, be due to a chemical change or to a preferential leaching out of certain constituents by flow of ground water.

To handle the material-balance computation in a reservoir of considerable thickness, observations on the properties of fluids at different elevations in the reservoir appear to be necessary. No general relationship applicable to petroleum reservoirs is known, and the information obtained to date does not indicate that such is possible. Reservoirs are likely to remain individual with regard to variation of properties with elevation.

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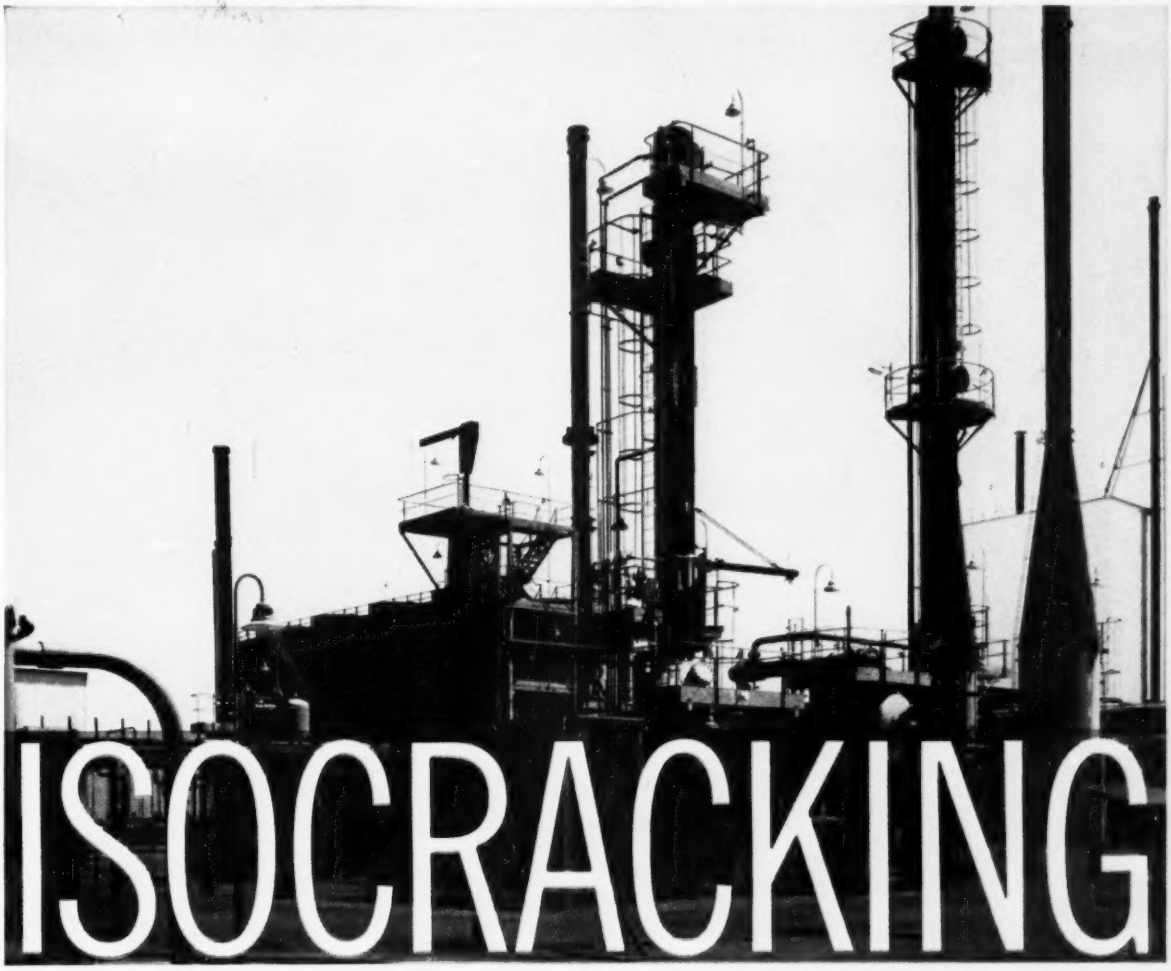

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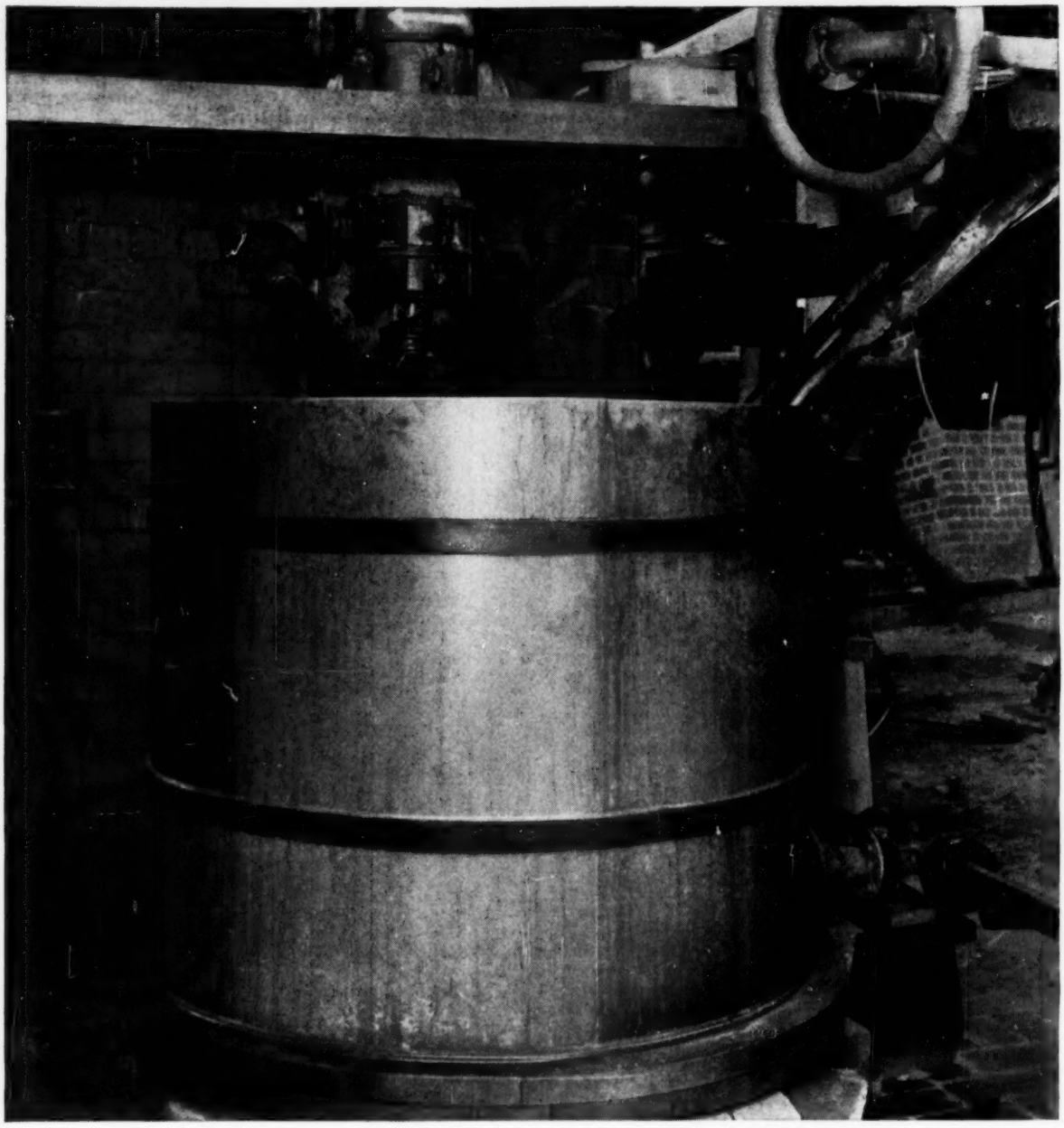

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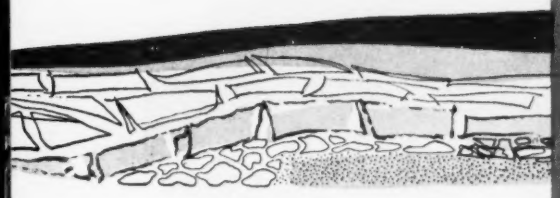

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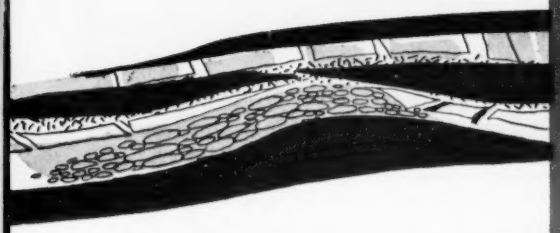

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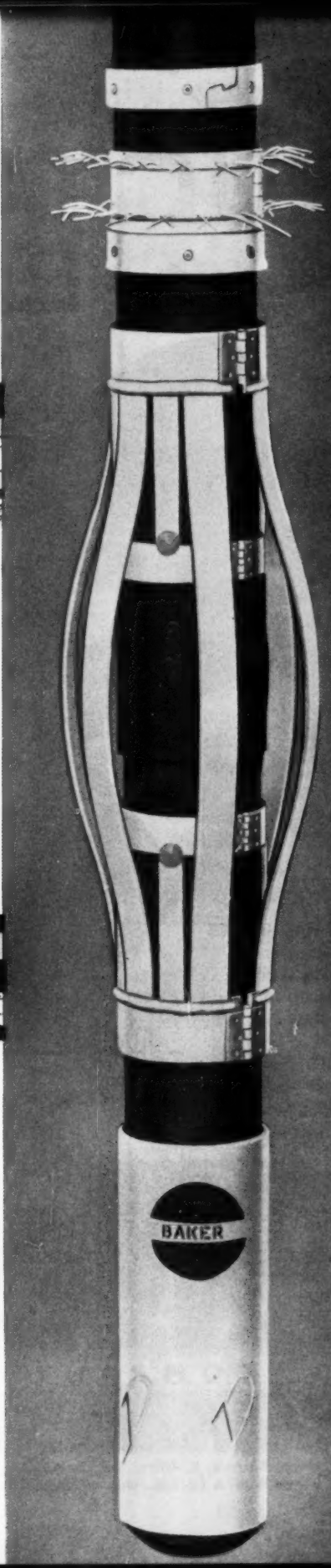

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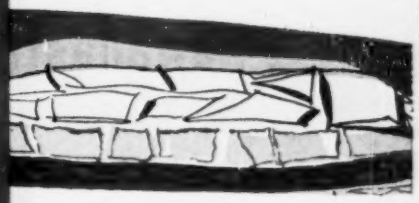

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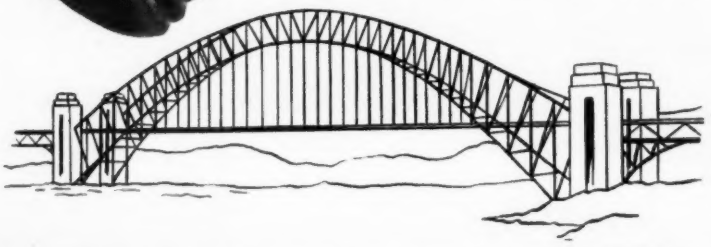

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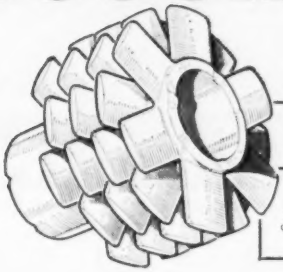

TUBE SIZE	FIN DIMENSIONS	FIN PITCH	SURFACE AREA PER FOOT	MATERIAL
2 in. outside diameter	5/8 in. high, 5/64 in. thick	4 per inch	3.6 sq. ft.	Mild Steel
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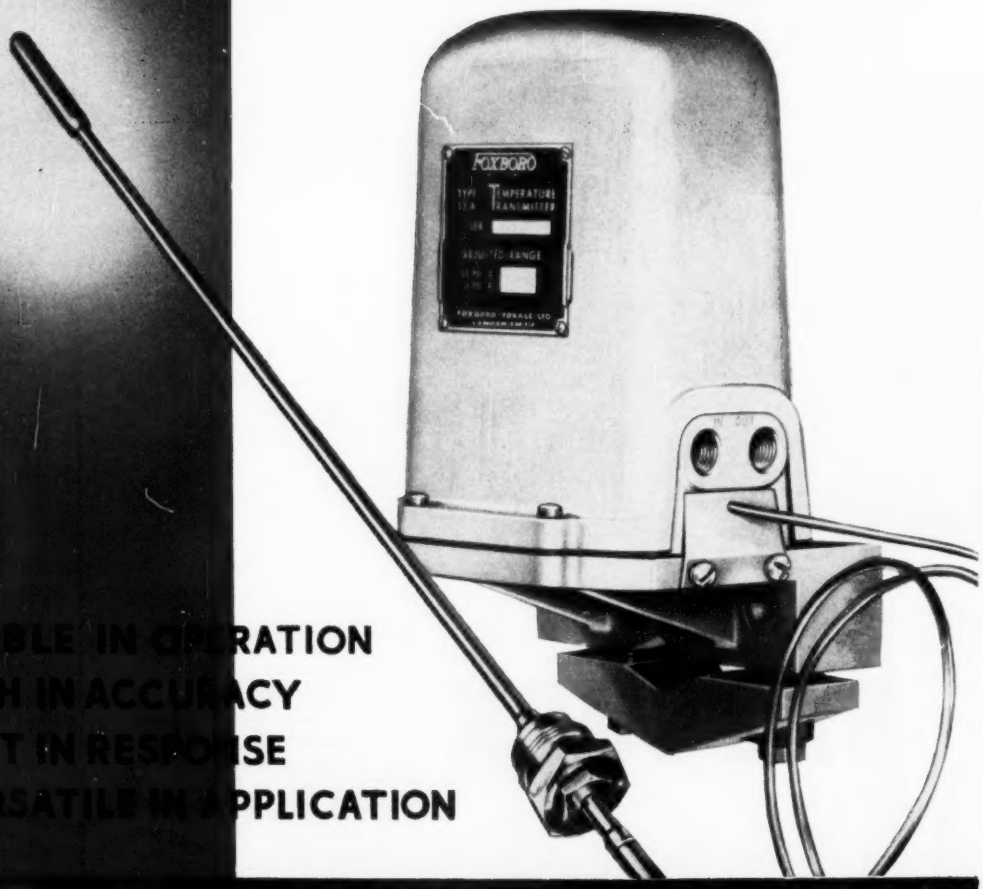

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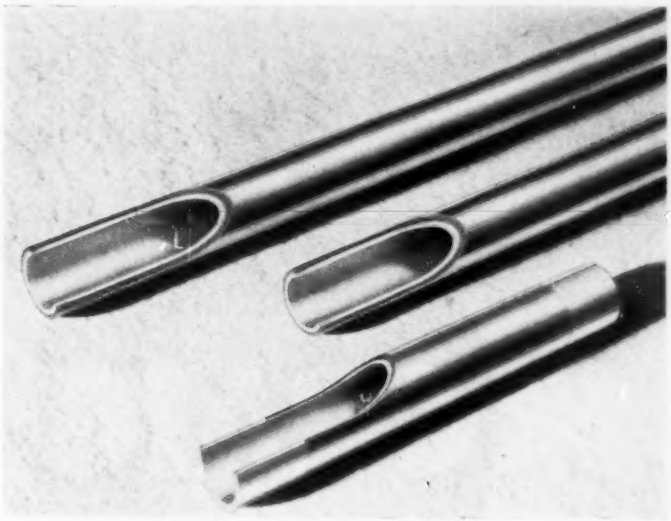

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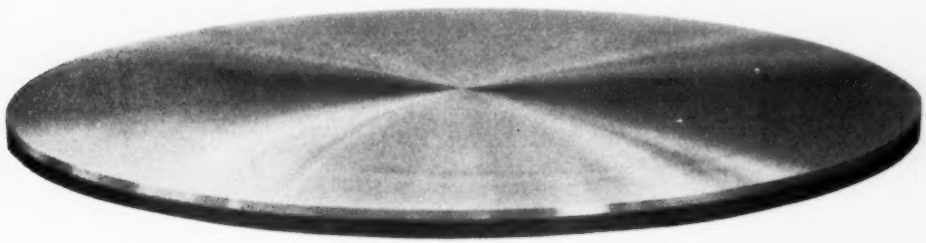

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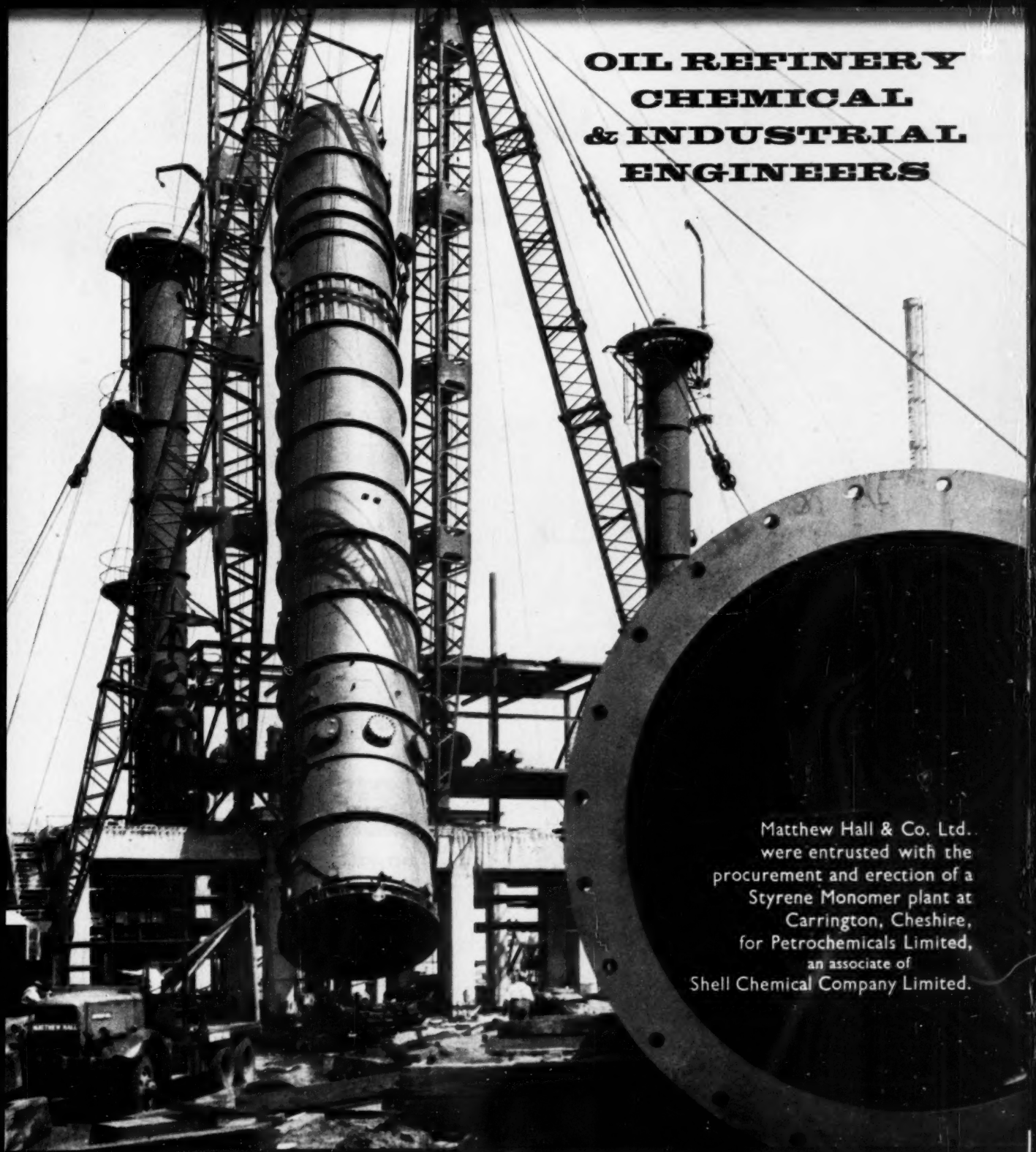

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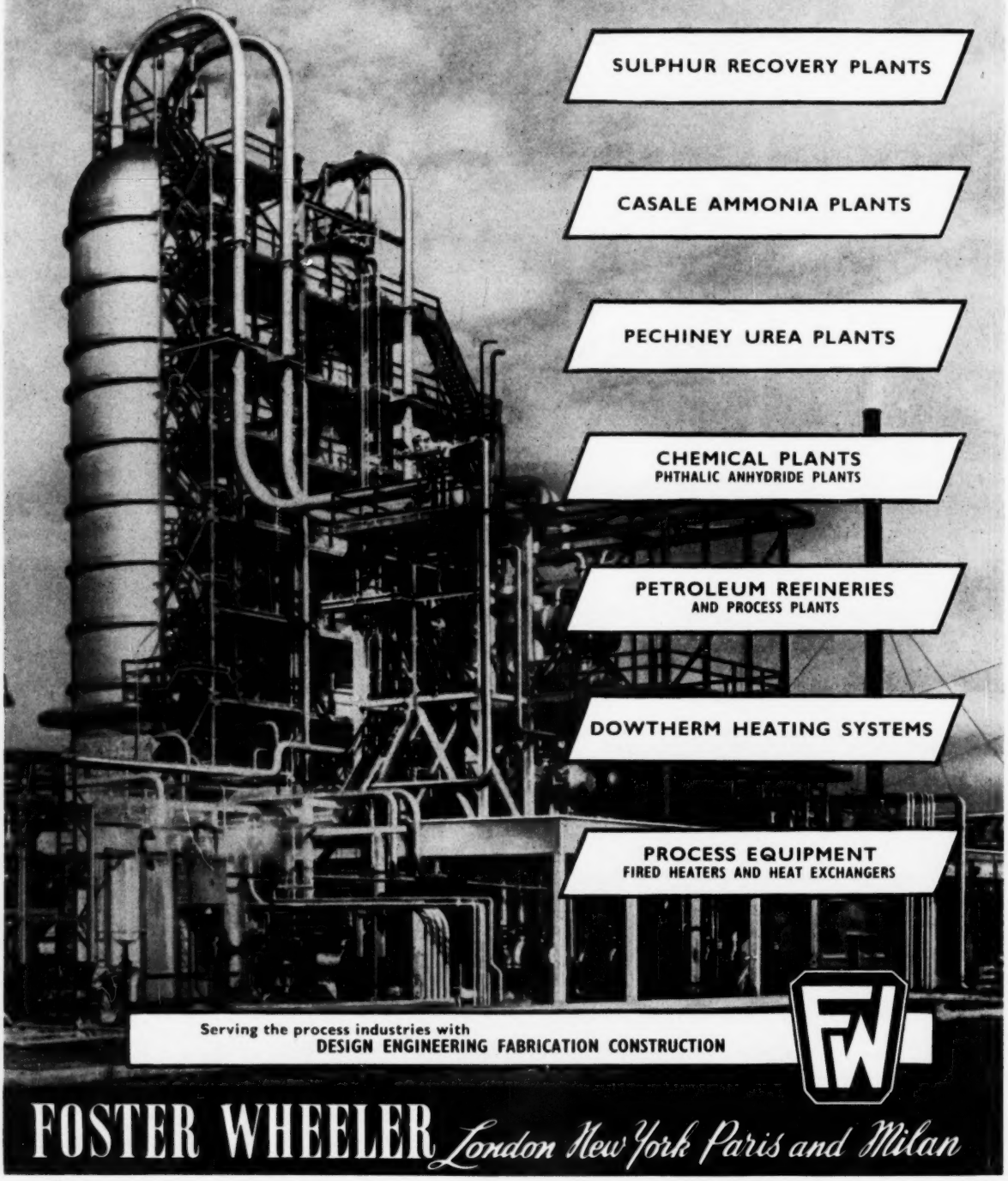

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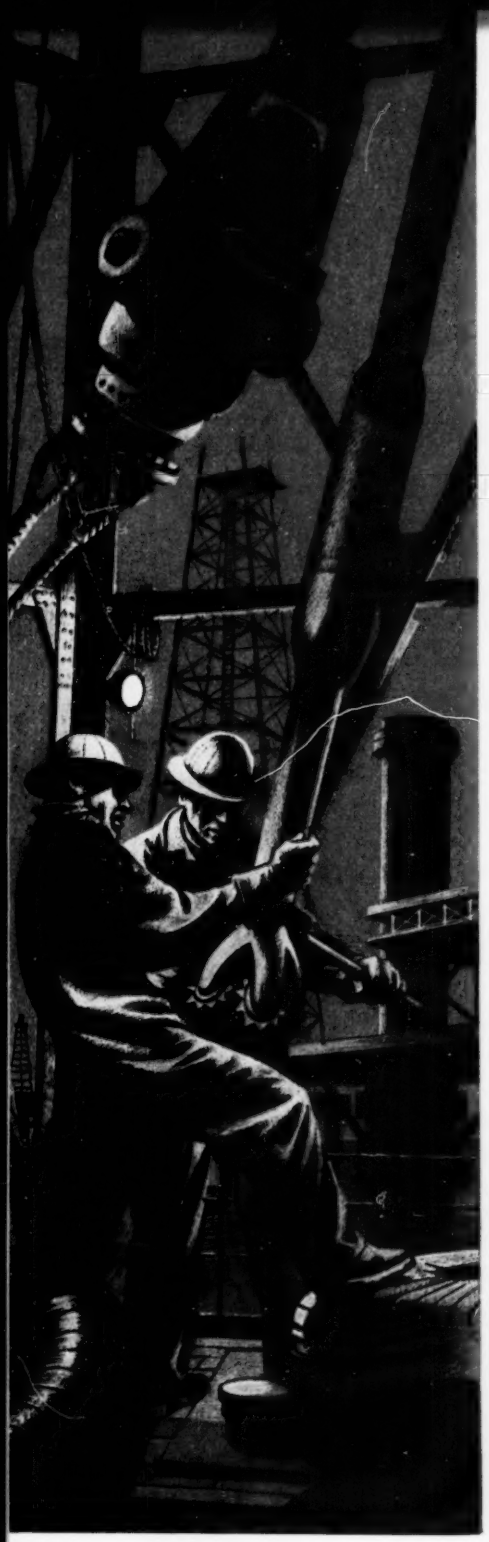

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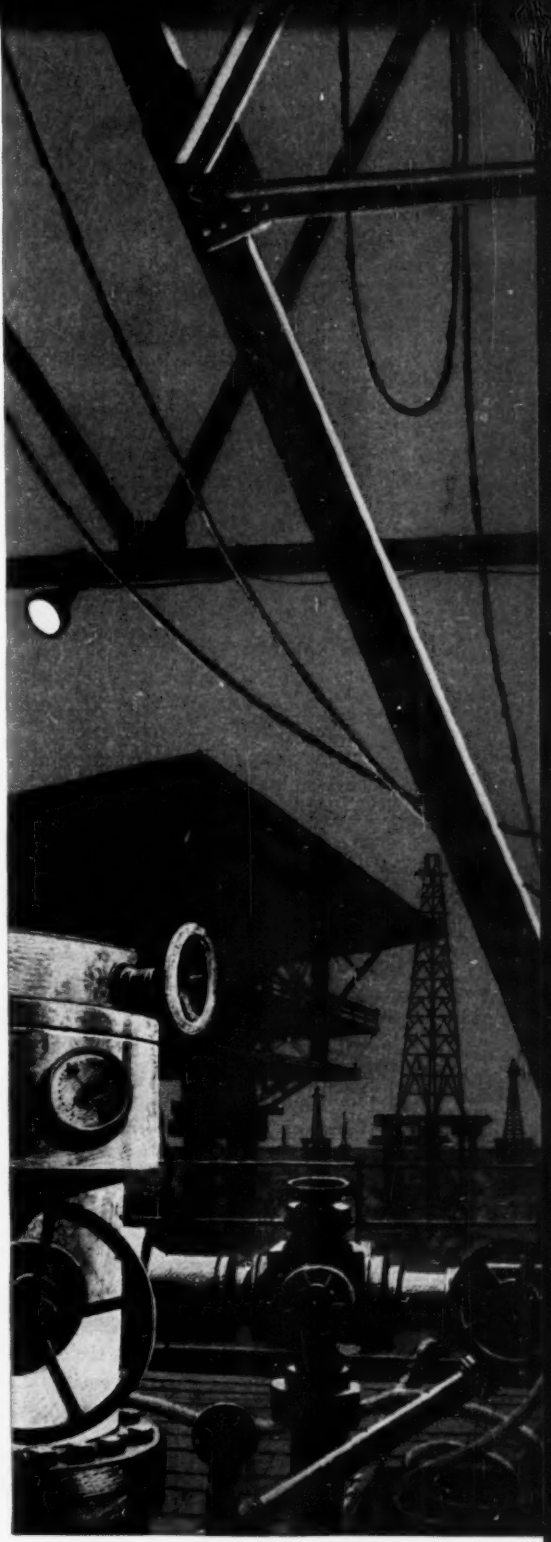

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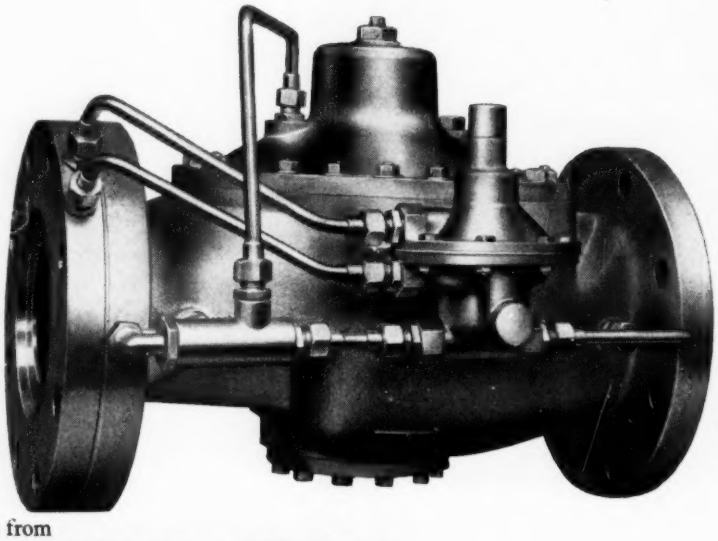

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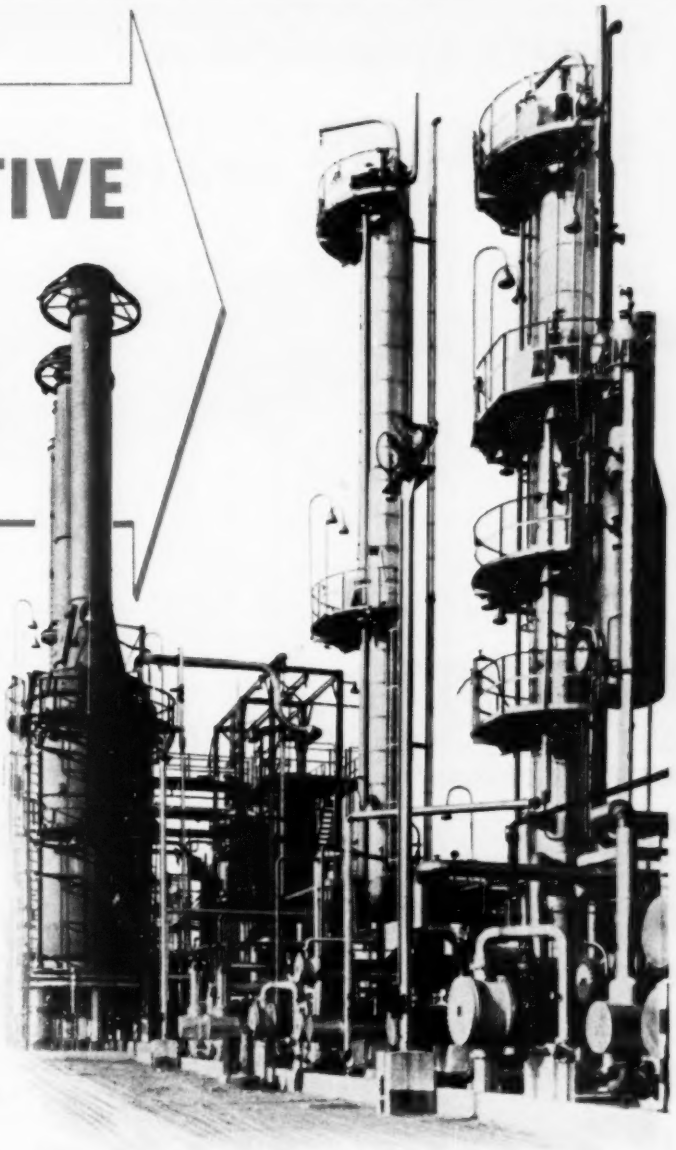

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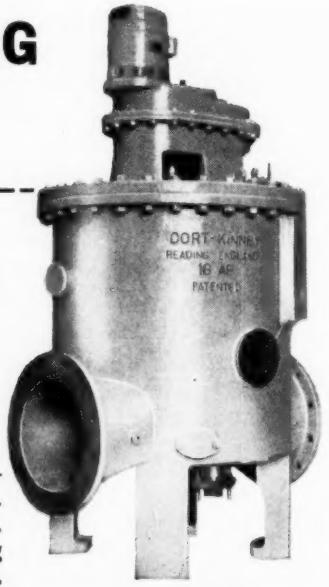

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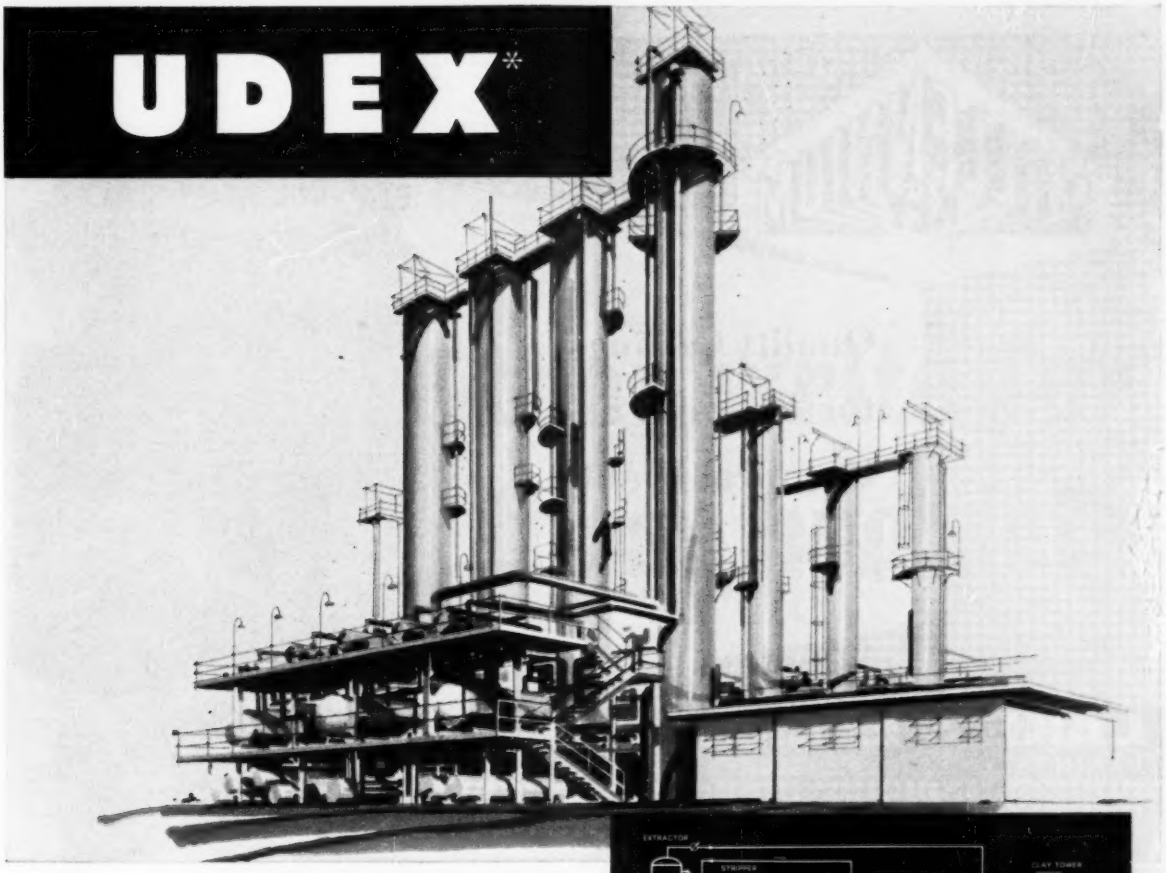

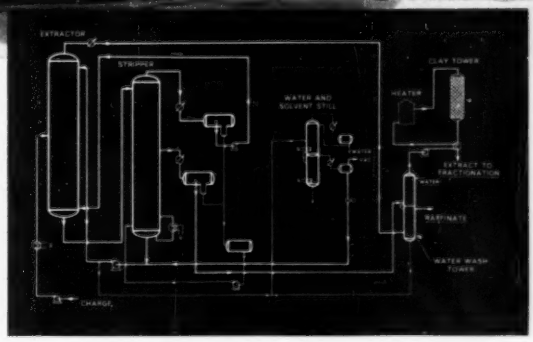

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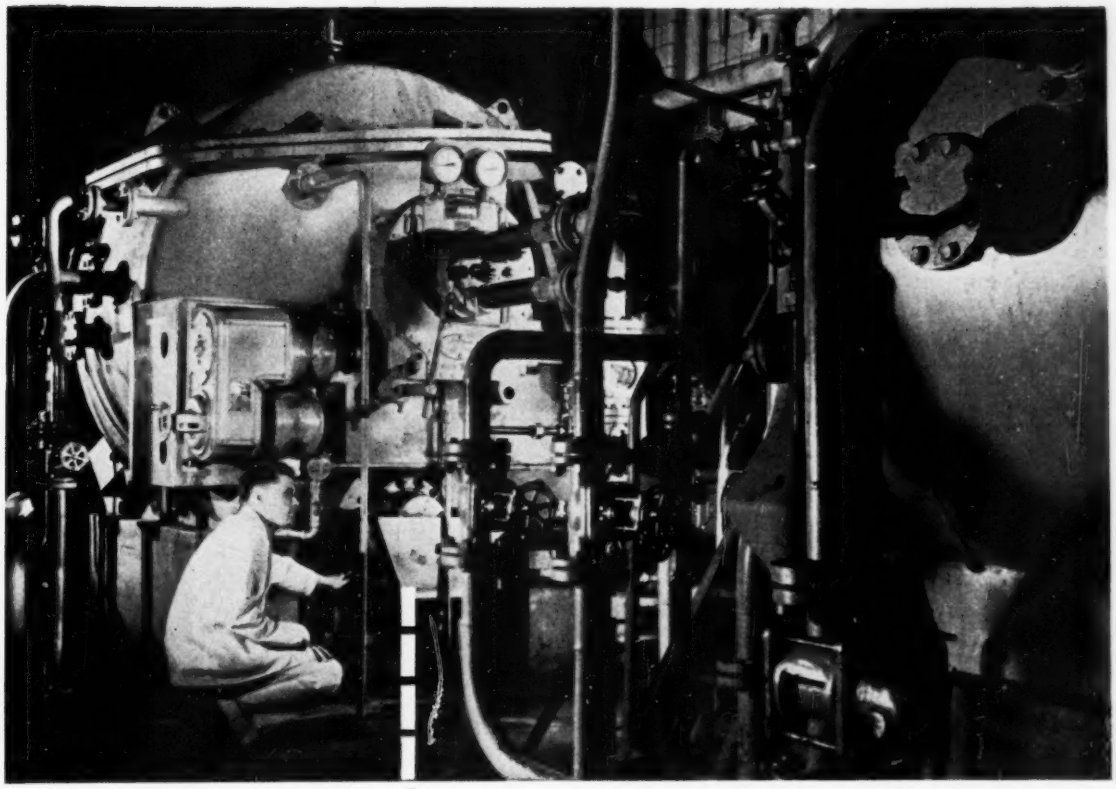

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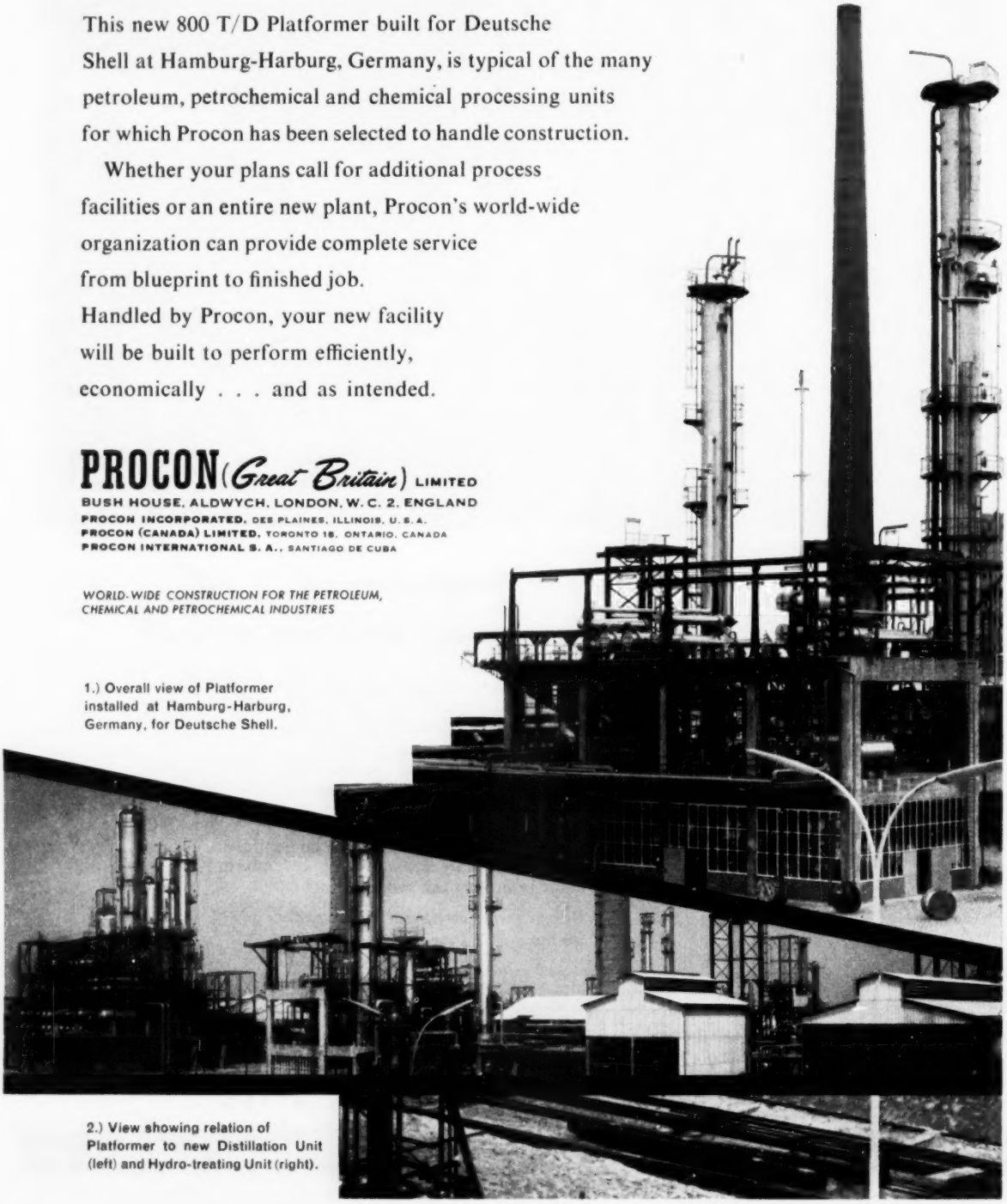

1.) Overall view of Platformer installed at Hamburg-Harburg, Germany, for Deutsche Shell.

2.) View showing relation of Platformer to new Distillation Unit (left) and Hydro-treating Unit (right).

ABSTRACTS

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1. Depositional topography—examples and theory. D. C. van Siclen. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1897–913.—Depositional topography, which in profile resembles the classic delta, is demonstrated with electric well-log cross-sections and isopach maps in the late Pennsylvanian and early Permian of W. Texas. Distinctive limestone beds can be traced readily over the undaform (top-set beds) and down the clinoform (fore-set slope), where they thin and commonly disappear, or in some places grade into resistive black shale which extends far out on to the fondoform (bottom-set beds).

Recognition of depositional topography improves stratigraphic correlations and the understanding of depositional processes and history. Reservoir beds related to the topography can be mapped and traps sought along them, and the relations of depositional topography to structure may disclose structural features. E. N. T.

2. Stratigraphic classification and terminology. H. D. Hedberg. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1881–96.—This paper attempts to present an overall simplified picture of the principles and practice of stratigraphic classification and terminology, with the objective of advancing general uniformity of usage.

Stratigraphic classification is the organization of the sequence of rock strata in the earth's crust into units under the various categories of classification provided by the many different attributes of these rocks. Stratigraphic terminology is concerned with the development of terms for these units. E. N. T.

3. Compressibility of sandstones at low to moderate pressures. I. Fatt. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1924–57.—Current research on oil-well drilling and production problems has created a need for basic mechanical data on reservoir rocks at low to moderate pressures (0–15,000 p.s.i.). These research programmes are aimed at: (1) improving drilling methods; (2) developing better hydraulic fracturing procedures; and (3) improving understanding of the mechanism of subsidence.

Bulk vol compressibilities of petroleum-bearing sandstones were measured in the range 0–15,000 p.s.i. Compressibilities were found to be a function of pressure, rock composition, and

texture. If sandstones are divided into two classes, one with well-sorted, well-rounded grains, the other with poorly-sorted, angular grains, then within a class the compressibility is a linear function of the amount of intergranular material. A useful model for a sandstone is the sphere pack composed of a mixture of very hard and very soft spheres. This model correctly predicts: (*a*) the pressure at which grains crush; (*b*) the compressibility of the intergranular material; and (*c*) the relation between compressibility and pressure.

E. N. T.

4. Pore structure in sandstones by compressible sphere-pack models. I. Fatt. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1914–23.—Porosity and flow measurements made on packs of rubber spheres under compression indicate that ideal sphere packs do not model the flow properties of consolidated sandstones. Packs of rubber cubes have plate-like pore spaces. Under compression, brine-saturated packs of rubber cubes display the same rapid increase in electrical conductivity observed when brine-saturated sandstones are compressed. This observation leads to the hypothesis that pore spaces in consolidated sandstones are plate-like, *i.e.* they have two large and one small dimension. Compression of consolidated sandstone causes collapse of these plate-like pores.

E. N. T.

5. Ancient sediments of Bahaman type. F. W. Beales. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1845–80.—Direct precipitation of calcium carbonate from sea water resulting in the formation of bahamites, or under more active water conditions of oölites, has probably formed very considerable thicknesses of limestone that occur throughout the geologic column from late Precambrian to Recent time. The precipitation of calcium carbonate upon banks is probably a self-regulating process more than capable of keeping pace with the rate of subsidence. It is equally capable of slowing down when the water over the banks gets too shallow and circulation is impeded. Because of this, bahamite deposits can be expected to form persistent barriers to evaporite basins, or to separate other carbonate facies types. Recognition of the bahamite deposits and the role played by them in such conditions helps greatly in the interpretation of the ecological pattern.

True clastic limestones (excluding penecontemporaneous skeletal fragment limestones) derived from the breakdown of pre-existing limestone are not as common as bahamites. They are much more restricted in regional extent and, being local deposits, they possess considerable sedimentary individuality.

A theory of aragonite needle agglutination for oölith growth is more satisfactory than one of direct precipitation. Although the local detailed patterns of oölite–bahamite accumulation are complex, controlled by currents and turbulence, the regional distribution of these oölites is likely to be simple, and follows a regional marginal trend associated with skeletal limestones that are also of potential reservoir interest.

If the interpretations of the conditions of deposition are correct, certain applications of very considerable economic importance may be possible in some areas.

Major oilfields having been recognized as occurring in the marginal zones of bahamite deposits, it is suggested that we should now reverse the process and find new fields by predicting the likely ecological pattern of bahamite limestones wherever they are recognized.

E. N. T.

6. Application of DST to hydrodynamic studies. H. K. van Poollen and S. J. Bateman. *World Oil*, 1958, **147** (1), 90.—The application of hydrodynamic principles may become important in exploration, particularly in the search for stratigraphic traps. The principles of hydrodynamics are discussed, and it is shown how oil and gas accumulations can occur off structure when a hydrodynamic gradient is present. The significance of the potentiometric surface is indicated and the need for properly interpreted drill stem tests for investigating hydrodynamic conditions is emphasized.

Diagrams show how the correct aquifer pressure can be extrapolated from typical DST charts, and field examples from the Williston basin, N. Dakota, are given. Errors in interpretation of the charts are discussed, and it is shown that an initial closed-in pressure is beneficial, the closed-in time being at least 60 minutes. 11 refs.

C. A. F.

7. Oklahoma "Wilcox"—an aid in finding deeper structures. R. C. Tuttle. *World Oil*, 1958, **147** (2), 71.—There are good possibilities for oil accumulations below the Wilcox in E. Oklahoma as indicated by recent developments in McClain and Cleveland. There has been little drilling in these deeper zones in the area, although reservoirs have been found in the Lower Simpson and the Arbuckle. Depths to these formations are relatively shallow, and accumulations should prove profitable. The stratigraphy of the area is briefly described.

C. A. F.

8. Palæozoic stratigraphy and oil possibilities of Kaiparowits region, Utah. E. B. Heylmun. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1781–811.—The Kaiparowits region, as defined in this report, covers more than 8500 sq. miles in S. Utah. It is essentially a part of a great platform area between the Paradox basin on the E. and the Great basin on the W. The Kaibab and Circle Cliffs upwarps, separated by the Kaiparowits basin, are the major structural elements in the region.

Cambrian, Devonian, Mississippian, Pennsylvanian, and Permian sedimentary units are present in the subsurface, of which only the Permian is exposed.

The Kaiparowits region has remarkably few major faults except in the W. part. A number of anticlinal features exist that have not been drilled for oil or gas, and stratigraphic conditions are favourable for petroleum production at many localities.

E. N. T.

9. Geology of Northern Soledad basin, Los Angeles County, California. W. R. Muehlberger. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1812–44.—The Ventura basin, a narrow, elongate trough of Tertiary sediments in the Transverse Range province of S. California, has had a complex tectonic history. At the E. end is a structurally distinct segment with its own history of deposition and deformation, called the Soledad basin. The San Gabriel fault, one of the major faults of S. California, marks the boundary between the basins. This fault marks the E. limit of both oil production and the thick section of marine sediments. Except for minor amounts of marine sediments, the Soledad basin is underlain by interlayered non-marine sedimentary and volcanic rocks. This study is concerned with the structural evolution and sequence of sedimentation in the N. part of the Soledad basin.

E. N. T.

10. Wyoming oil prospects are good. H. D. Thomas. *World Oil*, 1958, **147** (1), 83.—A summary of the geological history of Wyoming is presented, the state being made up of downwarped basins separated by mountain ranges. The main basins are Powder River, Big Horn, Wind River, Laramie, and Green River, and formations range from Cambrian through Tertiary. Production comes from Palæozoic and Mesozoic rocks, and the area is one of the oldest and most important producing regions of the U.S.A. *Ca* 200 fields are producing, and present proved reserves are estimated at *ca* 1·6 billion brl. Accumulations are in structural and stratigraphic traps, and many of the early fields were discovered by mapping surface anticlines. The future outlook for the area is good.

C. A. F.

11. Oil migration in recent sediments. A. L. Kidwell and J. M. Hunt. *World Oil*, 1958, **147** (1), 79.—Work has been

carried out in the Pedernales area of the Orinoco Delta of Venezuela in an attempt to detect primary oil migration within a section of Recent sediments. In this area there is an anticline with a disturbed diapiric core, flanked by Tertiary Las Piedras shales and siltstones unconformably overlain by Recent Paria beds. Samples from the youngest deposits were analysed and C_{14} age determinations made. Drilling established the presence of a sand lens which is *ca* 5000 years old, and the hydrocarbon extract from this sand has an apparent minimum age of *ca* 14,000 years. Hydrocarbon contents plotted *v.* depth showed an increase opposite the sand lens, but not for any other sand beds, all of which reached surface, not forming traps. Compaction was also measured; at a depth of 190 ft in the deepest hole, for example, the shale water content had fallen from 80 to 32%. The direction of movement of compaction water was studied by making pressure measurements; excess hydrostatic pressure values were found to be low near sands with surface communication and high opposite the sand trap.

The evidence from the area shows that primary migration starts early in the compaction phase. C. A. F.

12. Miocene foraminifera of Gulf of Suez region, Egypt. R. Said and M. A. Basiouni. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (8), 1958–77.—This paper lists 68 species of foraminifera from two Miocene sections which crop out in the region of the Gulf of Suez, S. of Wadi Feiran and E. of Abu Zenima. An analysis of the foraminiferal assemblages found in the sections studied by the writers and other workers in the region was made to elucidate the palæographic conditions of this rather complex basin of deposition. Also included are the results of a thin-section study of the harder rocks that intercalate the succession.

The distribution suggests the presence of a sill that separated the Miocene Gulf of Suez embayment from the N. Tethys epicontinental sea and a S. basin, an environment coinciding with data obtained by sedimentational inferences and geophysical methods. E. N. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

13. Buried fault indicated by seismic record data. S. M. Leventhal. *World Oil*, 1958, **147** (2), 75.—The seismic record of a N.–S. traverse through the Bonnet Carre field of S. Louisiana is presented, to show how it accurately delineated a buried fault which cuts the structure. There is excellent correlation between the record section and electric log data, and a subsurface structure map of the field is included. The traverse was made before the field was developed, using a portable 24-trace system with 4 marsh geophones per trace. 20% mixed circuiting was used, individual shot holes being normally spaced 1200 ft apart.

The discovery was completed in Jan. 1958 with production from *ca* 9000 and 9500 ft. C. A. F.

DRILLING

14. Can formation water be shut off for air drilling? O. Kiel. *World Oil*, 1958, **147** (1), 105.—The problem of water shut-off in air drilling has been studied in the lab, using sandstone and dolomite cores, in order to determine a means of reducing the permeability of a reservoir rock to a value at which fluid produced from it could be lifted economically with the cuttings. At present, a major disadvantage in air drilling is the problem of handling water entering a well whilst drilling; but the experiments showed that it was possible to reduce core permeability by an average of 99·3% by precipitating plugging agents in the pores. Results show that two soln are effective, each containing a water soluble inorganic material. Details of the testing equipment are given.

C. A. F.

15. Fluid grout for water control. W. Hower *et al.* *Petrol. Engr*, 1958, **30** (6), B26.—Various substances have been tried while searching for an effective solution to water intrusion problems in air drilling and water influx in producing wells. Of the many solutions tried, one appeared to give better results and have more desirable properties than the rest. The solution, a polymeric water gel, has a visc of *ca* 3 cP and remains in this visc region until it starts to set.

Applications are also visualized in sealing thief zones, in secondary recovery injections, and stabilizing soil conditions around mine shafts, dams, and tunnels. P. D. E.

16. New technique tests casing in the hole. L. C. M. Darling. *Petrol. Engr*, 1958, **30** (6), B119.—A simplified and practical technique for testing casing just prior to cementing has been developed and field tested by Macro Ltd of Calgary, Alberta, Canada. This method has been used to field test over a million ft of casing after it has been run in the hole and before cementing operations.

The idea includes a drillable seat which is located in the casing string just above the float collar or cementing shoe. The casing is run and the well circulated in the conventional manner. A plug which fits into the drillable seat is dropped into the casing to seal it at the bottom. With the lower end of the casing string sealed off it can be pressure tested prior to cementing.

After a satisfactory casing pressure test, the plug is retrieved by a sand line or a wire line and the casing can then be cemented in the usual way. P. D. E.

17. Borehole to the earth's mantle. T. F. Gaskell. *Nature, Lond.*, 1958, **182**, 692–5.—A broad outline of drilling methods and techniques, simply explained. Drilling methods are described in general terms, and the applications of rotary drills and turbo-drills are discussed. Other aspects include the "hand-over-hand" process of handling drill-pipe, and the formation and use of drilling mud.

Among the other topics discussed are methods of making holes in the harder rocks that are not normally encountered in oil-drilling, and the technique of under-sea drilling.

H. C. E.

18. Casing-joint thread lock. M. True and W. A. Pitts. *Oil Gas J.*, 2.6.58, **56** (22), 116.—A cpd and technique have been developed for use in locking casing joints. This procedure prevents disengagement of the lower section from the main casing string as drilling operations proceed below it. A thermo-setting epoxy resin is substituted for the thread dope on the joints to be locked. Lab tests indicate this produces a joint with a greater resistance to break-out than that obtained by tack-welding the made-up joints. In use, casing collars are removed and all threads cleaned and coated with the cpd, after which the joints are made up in the normal way and may be immediately lowered into the hole. The well temp is sufficient to cause setting. Pot-life of the cpd is *ca* 2 hr. The joints maintain their strength up to 350° F.

J. C. M. T.

19. Drilling in world's record time. E. Sands. *Petrol. Engr*, 1958, **30** (10), B48.—On 4 June 1958 well No. 14 in the Caillou Island field (in Timbolier Bay, SW. of New Orleans) was drilled to its projected depth of 13,778 ft after roughly 14 days of drilling. Thus a drilling rate of approx 1000 ft/day was accomplished, which is thought to be a world record.

M. F. M.

PRODUCTION

20. Does bubble formation affect reservoir performance? D. R. Wieland. *World Oil*, 1958, **147** (1), 129.—Recent experimental work on bubble formation is briefly reviewed in relation to its influence on oil recovery. The formation of bubbles can change the $\frac{kg}{ko}$ ratio appreciably, thus affecting the recovery from gas-drive fields. It is emphasized that lab data should not be used to predict field behaviour because of the time factor, faster decline rates being used in experiments. In a study with limestone cores it has been suggested that displacement by injected gas can give a lower recovery than solution-gas drive in the lab, giving results more comparable with those obtained in the reservoir. 5 refs. C. A. F.

21. Optimum water flood development. B. Murphy. *World Oil*, 1958, **147** (1), 112.—The factors which must be considered to secure the max profit from a pattern water flood project in fields which are depleted, or nearly so, are discussed in terms of flood practice and reservoir mechanics, basic controls such as geological and leasing considerations, and economic factors. A procedure for development is recommended, and it is concluded that the life of the project depends primarily on the capacity and number of injection wells, given sufficient production capacity, with development costs being mainly a function of well density and operating costs. The number of possible schemes depends on basic development controls. 7 refs. C. A. F.

22. Spraberry water flood will be profitable. L. F. Elkins. *World Oil*, 1958, **147** (2), 94.—Recent studies have indicated that the Spraberry sand in W. Texas can be successfully water flooded, possibly increasing recovery by as much as 1500 brl/acre. After an initial development boom in 1951 there was a marked drop in activity when wells were found to decline rapidly. All the sands are very tight, but there is an extensive vertical fracture system. Oil in place should be *ca* 6000 brl/acre max, but cumulative recovery averages only 5–8% of this. This may be due to retentive capillary forces because of the large number of fractures, and conventional secondary recovery methods would not therefore apply. Pilot floods have been carried out, and in one case water was injected into three wells on a normal five-spot pattern with promising results. Estimated profits from operating a large-scale flood are $1·4 million to 2 million per section. C. A. F.

23. A new method of producing viscous crudes. N. Lista. *Petrol. Engr*, 1958, **30** (6), B21-6.—A new production method called natural dilution lifting has been developed by Socony Mobil de Venezuela in the Guico area of Central Anzoategui in E. Venezuela. This new idea has proved to be an economical and convenient method for producing heavy viscous crude oil, as well as offering the advantages of dual completions. Excess energy that would otherwise be dissipated in the natural flowing production of light crude is utilized. Light crude from one zone was mixed in the tubing string with heavy oil from a second zone, and although a blend is produced, the two zones remain entirely separated, with no possibility of contamination. Control of the light oil reservoir is possible at all times because it can be tested separately and pressure surveys can be run when necessary. P. D. E.

24. How to determine the water content of natural gases. J. J. McKetta and A. H. Wehe. *World Oil*, 1958, **147** (1), 122.—A chart is presented which enables the water content of natural gases to be determined up to a pressure of 10,000 p.s.i. and for a temp range of −50° to 300° F. It is computed for a gravity of 0·6, but a subsidiary chart for gravity correction is incorporated, as well as a salinity correction diagram. The chart is based on the work of a number of authors, particularly that of Dodson and Standing, and an example of its use is given. 13 refs. C. A. F.

25. Secondary recovery by butane injection in San Pedro (Peru) Block D. R. Moscrip. *Petrol. Engr*, 1958, **30** (10), B19.—Secondary recovery involving butane injection, followed by injected gas, has been in progress in the San Pedro pool in NW. Peru for the past six years. A substantial increase in oil recovery has been obtained, and the ultimate recovery of the reservoir is expected to be 350,000 brl of oil. This is much higher than would have been recovered ultimately by primary operations. Substantially all of the injected butane can be recovered with the produced fluids. M. F. M.

26. A case for 640-acre spacing of gas wells. P. R. Waddle. *Petrol. Engr*, 1958, **30** (10), B28.—Well spacing has been a source of disagreement since the early days of the petroleum industry. The present trend in well spacing is towards wider spacing for gas wells to effect efficient recovery and conservation. Spacing of 640 acres/well has been the pattern most frequently employed in recent years in Texas fields. This is shown by extensive data presented in the paper. M. F. M.

27. Saturation pressure—a reservoir evaluation tool. F. W. Cole. *World Oil*, 1958, **147** (1), 144.—Saturation pressure is defined as the highest pressure at which a bubble of gas will be evolved from solution from oil as the pressure is decreased. A knowledge of its value is very useful for planning the development of a field by providing information about the presence of a gas cap. It should be determined whether the reservoir sample used for pressure measurements is representative of the reservoir fluid; this can be done by comparing the original gas in solution measured on the sample with the produced gas/oil ratio. These values should be equal until the pressure falls below saturation pressure. C. A. F.

28. In the North Homer field, Louisiana, gas repressuring methods prove successful. P. R. Waddle. *World Oil*, 1958, **147** (1), 134.—The North Homer (Nacatoch sand) field in Louisiana was found in 1919 and has been repressured since 1934. Primary drives are solution gas and gravity drainage. In Jan. 1958 cumulative recovery was *ca* 52·5 million brl, or *ca* 51% of original oil in place; 12% of this is attributed to repressuring. Ultimate recovery is estimated to be 61% of original oil in place. The geology and reservoir characteristics of the field are described. It consists of a dome, *ca* 9 miles in dia, cut by an E.–W. trending fault downthrowing to the S. Effective pay thickness averages *ca* 55 ft with a productive area of *ca* 1300 acres. Porosity is approx 33%, and permeability averages 200 mD. Average connate water saturation is estimated at 40%. The production history of the field is outlined and production curves are included. The relatively steep dip of the structure (500 ft/mile) has enabled gravity to influence production, structurally low wells having higher producing rates. C. A. F.

29. Newest well stimulation technique. H. H. Mohaupt and H. A. Metzger. *Petrol. Engr*, 1958, **30** (9), B30-4.—A specially designed explosive charge, run in on wire line and initiated under a fluid column, generates rapidly oscillating pressure waves that cause consolidated formations to rupture along a horizontal plane. Principal use to date has been in low- and medium-pressure wells, where the max head of fluid was equivalent to 1200 ft of water. A prerequisite for any successful stimulation treatment is that the formations contain commercial quantities of oil held in low, permeable, porous sections either in limestone, dolomites, or sandstones. The need for careful study and planning is emphasized and recommendations given as to whether or not this type of stimulation will be successful. Notable case histories are also included. M. F. M.

30. Permeability log determination. S. T. Yuster and A. S. Odeh. *Petrol. Engr*, 1958, **30** (9), B36–8.—Equations have been derived which permit the calculation of single phase liq permeability as a function of depth, where porosity and saturation data are known. The equations indicate that if the permeability were known at a certain depth, then taking this as a reference, permeabilities at any other depth could be calculated, provided porosity and saturation data are available. Calculations were performed for two field cases, and results were compared with measured values. This showed a good qualitative and a fair quantitative agreement between the calculated and measured values. It is suggested that additional investigation on actual field data is warranted before the merit of this method is decided upon. M. F. M.

31. Remedial treatment of water injected wells. D. E. Menzie. *Petrol. Engr*, 1958, **30** (10), B88.—Although there are several methods of improving injectivity, field tests of wells using surface-active agents point to new heights of effectiveness. There are many types of surface-active agents, and as yet it is not fully understood how the agents work and what changes take place in the formation. The action of the surface-active agent is beneficial in two ways: (1) the agent reduces the interfacial tension between the oil and water, with the result that oil saturation near the well bore is removed; (2) a layer of surface-active agent is spread around all movable mud and clay particles. The agent coats these solids and moves them away from the well bore. The net result is an improvement in water-injection rates. M. F. M.

32. Oil recovery by *in situ* combustion. J. S. McNiel, Jr and J. T. Moss. *Petrol. Engr*, 1958, **30** (7), B29.—With adequate knowledge of operating variables peculiar to the *in situ* combustion process, it is possible to investigate the basic design considerations which will eventually establish economics for a specific field operation.

Some factors may be predicted, but all factors concerned with rate are affected by variables determined from the multiphase flow conditions downstream from the combustion front, and more work will be necessary before these are fully understood.

At the present time, seven test projects or field experiments have been completed, nine projects are in progress, and four or more projects are in the planning stage. P. D. E.

33. Annular friction losses between tubing and casing. R. W. Brown. *Petrol. Engr*, 1958, **30** (9), B22–6.—Well treatments by acidizing or fracturing can be planned more efficiently and with more effective results when friction losses are known. This article presents a method of calculating the annular friction and substantiates the method with field results. The pressure drop due to friction of various types of fluids in the annulus of several combinations of tubing and casing are given and field applications are discussed. M. F. M.

34. CATC's quadruple string completion. W. W. Poimboeuf and R. Henderson. *World Oil*, 1958, **147** (2), 91.—A quadruple string multiple well installation, the first to be carried out in the industry, is described. The well is a deviated hole in the West Delta Block 30 field off the coast of Louisiana, and four parallel strings of 2⅜-inch o.d. tubing were used. Four oil producing zones have been completed for production, the zones being fairly closely spaced with promise of a long life. The lowest zone is at a depth of *ca* 9800 ft. The increased allowable resulting from this completion should offset the additional completion costs. A diagram of the installation is included. C. A. F.

35. Survey results show fracturing can help secondary recovery. E. T. Guerrero. *World Oil*, 1958, **147** (1), 126.—Although experience has shown that properly controlled hydraulic fracturing results in increased production or injection rates, there has been some objection to its use because it is claimed that extensive fracturing may occur, giving channelling and reduced sweep-efficiency in secondary recovery operations. Results of field experience of hydraulic fracturing in secondary recovery are presented, and it is concluded that it can be beneficial in many secondary recovery projects by breaking through permeability barriers by the well bore. *Ca* 80% of treated producing wells in these projects show an improved recovery, and for injection wells the improvement is greater. C. A. F.

36. Fresh water fracturing can cut treatment costs. R. E. Hurst, J. T. Rollins, and H. A. Stewart. *World Oil*, 1958, **147** (1), 117.—Fresh water has been used successfully as a fracturing fluid in the Permian basin of W. Texas. 100 treatments have been carried out, and, as well as being cheaper in most cases than oil base fluids, it can also give better results due to the solution and removal of salt from reservoir rocks. Halite occurs as a cement in the rocks, and in some reservoirs water containing 2–4% HCl has been used to remove salt and dissolve limestone simultaneously. Removal of salt by the fracturing treatment has been confirmed by water analyses before and after treatment. Analyses of reservoirs in the Permian basin showing salt content of crude, produced brine, and rock are tabulated and discussed, and a few case histories are presented. A table showing results of treatments in terms of productivity for different formations is also included. Out of 100 wells treated, the average production per well before treatment was 4·98 b.o.p.d. and 3·08 b.w.p.d. After treatment this increased to 32·32 b.o.p.d. and 47·15 b.w.p.d. After 30 days production had fallen to 27·95 b.o.p.d. and 23·04 b.w.p.d. C. A. F.

37. 50% recovery by fire drive. U. S. Swaminathan. *Oil Gas J.*, 2.6.58, **56** (22), 129.—Successful lab experiments on oil recovery by *in situ* combustion are described. Combustion in an oil and water impregnated sand supplied with injected air takes place at *ca* 300° C. No flame is possible in the restricted space between the sand grains, but the reaction is self-sustaining and a combustion zone advances steadily, pushing forward an oil "bank." It is estimated that under oilfield conditions *ca* 50% of the oil in place may be recovered, 10–20% being burned in the process. Experiments in an actual oil reservoir are in progress. J. C. M. T.

38. Sonic pump bows in. Anon. *Petrol. Engr*, 1958, **30** (10), B25.—Over the past three years the sonic pump has undergone exhaustive tests under the toughest oilfield conditions. The manufacturers of the pump, Jonston Testers Inc., report that the pump has successfully lifted crude in 10° API gravity range for long periods of time without repair. In several instances it has handled crude with a sand content of up to 80%. It is claimed that the pump develops an efficiency of 60–70% based on the b.h.p. supplied by the prime mover. The paper gives a full description of the pump (with pictures and diagrams) and some case histories. M. F. M.

OILFIELD DEVELOPMENT

39. Gas hunted in Eastern Canada. Anon. *World Petrol.*, 1958, **29** (5), 85.—Oil production in E. Canada in 1957 increased by 5% to 627,000 brl and gas by 11% to 14·4 billion cu. ft. Drilling in the St Lawrence lowlands and the Maritimes region has continued to be disappointing. No oil and only two gas wells were completed in 1957, but exploration is continuing. In Ontario there has been active offshore geophysical work, and recent drilling has resulted in one gas discovery in Lake Erie. Offshore drilling is continuing in 1958, and a drilling barge has been introduced. Previous

work has involved drilling from platforms or towers. 441 wells were drilled in E. Canada in 1957, approx the same number as in 1956. C. A. F.

40. Exploration up sharply in Western Canada. W. A. Hiles and G. J. McMurtry. *World Petrol.*, 1958, **29** (5), 74.—Exploration activity in W. Canada in 1957 is reviewed, the most important feature being the high discovery rates, with the most important fields being found in Alberta and British Columbia, and a lower rate of development drilling. 49% of the discoveries were made in British Columbia, compared to only 5% in Manitoba. Completions totalled 1943 compared with 2383 in 1956, but Saskatchewan and British Columbia showed increases of 16% and 15%. Important discoveries in Alberta were the Innisfail D-3 reef field, the Devonian in the Swan–Virginia Hills–Kaybob areas, and the Mississippian in the foothills. Tables summarizing oil developments in W. Canada are included. C. A. F.

41. Innisfail—1957's top reef discovery. W. M. Luthy. *World Petrol.*, 1958, **29** (5), 62.—Until the discovery of Innisfail reef field between Calgary and Edmonton, Alberta, in 1957 there had been no major reef discovery since 1952. There has been rapid development of the field, and by the end of 9 months 34 wells were completed. Production is from the Devonian D-3 reef, and the productive area may cover *ca* 8000–9000 acres. Max pay section between gas/oil and oil/water contacts is 147 ft, and depth to pay is *ca* 8000 ft. Porosity ranges from 4 to 20%, and permeability is very variable. Connate water is 15%. Recoverable reserves are conservatively estimated at over 50,000,000 brl. The field is well to the S. of earlier reef discoveries, and it was located by drilling after detailed seismic work. C. A. F.

42. Outlook good for East Pakistan gas field. W. Sekules. *World Oil*, 1958, **147** (1), 154.—Gas was first found at Sylhet in E. Pakistan in 1955, but commercial production was not obtained until the third well was completed following a seismic survey in 1957. This has a potential of 15 million cu. ft/day, and estimated recoverable gas reserve is approx 200 billion cu. ft. The structure is an exposed dome with Pliocene overlying Miocene rocks. Pay is sand at *ca* 4000 ft. The well is at present shut in, awaiting production outlet, but an 8-inch pipeline is planned to carry the gas some 145 miles SW. to markets at Dacca. Surface indications suggest that gas will be found elsewhere in E. Pakistan. C. A. F.

43. Bunjani oilfield, Croatia. V. Peros. *Nafta* (*Yugoslavia*), 1958, **9** (8), 215–27.—The Bunjani oilfield is the SE. field of the Klostar–Sumecani–Bunjani group along a 10-km SE. trend. The field extends 2·2 miles NW.–SW. and has a productive area of 683·5 acres. The reservoir is a monoclinal series of poorly consolidated Oligomiocene sands and sandstones, and a series of fractured and weathered basement rocks. The Oligomiocene formation begins at an average drilling depth of 2300 ft, dipping 8° SW. The average porosity to apply to the entire reservoir vol is taken as 23·2%. Reservoir studies indicated a recovery of only 11·5% of the oil originally in place during primary depletion by dissolved gas and partial water drive. It was also estimated that pressure maintenance recovery by water displacement would be deferred.

(Author's abstract.)

TRANSPORT AND STORAGE

44. Fluid agitation in tankcars. R. L. Bates. *Chem. Engng*, 1958, **65** (17), 136–42.—All the problems peculiar to agitation in tankcars come from physical situations such as the vessel geometry (length to dia ratio), the vessel position, and the facility for installing a mixer. Side-entering propeller agitators can be installed on a nozzle on one end of the tanker. Top-entering agitators, with radial discharging turbine impellers, are used on horizontal cyl tanks. Jet mixing, the earliest approach to circulating liq in tankcars, can also be used. The relative merits of these methods are discussed in the paper and limitations of each method emphasized. M. F. M.

45. Flexible oil barge. Anon. *Engineer* (*Lond.*), 1958, **206**, 485–6; *Inst. Petrol. Rev.* 1958, **12** (143), 368–9; *Fluid Hardl.*, 1958, 276–8; *Petrol. Times*, 24.10.58, **62** (1597), 874.—First commercially operational "Dracone," 5 ft dia, 100 ft long, capacity 10,000 gal, has undergone trials at towing speeds of up to 5·5 knots, after having been afloat 500 hr. Flexible skin is $\frac{1}{32}$ inch thick, of woven nylon fabric, with each surface coated with synthetic rubber. When empty the "Dracone" is wound on floating reel 9 ft long and 5 ft dia, for transport; it can be folded into a case for air transport (approx tare 1 ton). Future development includes models up to 300 ft long and 15 ft dia, to carry 1100 tons oil at max economical speed of 12 knots. A. C.

46. World's largest pipeline—55 inch. F. Brady. *Petrol. Engr*, 1958, **30** (10), D56.—Now under construction in Pittsburgh, Pennsylvania, are a pair of the world's largest dia gas transmission lines. The system will distribute a mixture of coke oven gas and stabilized natural gas to six U.S. steel corporation mills along Monongahela River. The line will have a capacity of 225,000,000 cu. ft/day and is designed to operate at 50 p.s.i. M. F. M.

47. Photogrammetry aids in pipeline location surveys. A. O. Quinn. *Pipe Line News*, 1958, **30** (9), 32A–33.—The development of photogrammetric techniques and the increased use of aerial photographs provide the pipeline location engineer with valuable aid to assist him in determining the most economic route for his pipeline. The paper discusses, with the aid of diagrams, the limits of usefulness of aerial photographs, the methods of correct interpretation, and the design and production of topographic maps by photogrammetric methods. M. F. M.

48. Pipelines find favour in transporting ethylene. H. C. Schutt and A. R. Mattioli. *Oil Gas J.*, 1.9.58, **56** (35), 150.—This concluding part of a three-part series discusses transmission of ethylene by pipeline through a special metering station. The possibility of shipping liq ethylene by barge or tankers is also considered. G. A. C.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

49. Refinery construction manual. H. M. Noel. *Petrol. Engr*, 1958, **30** (9), C20–24.—Economic studies are the first engineering tasks to be done on any proposed new refinery. The article discusses the various economic aspects of refinery construction, *i.e.* labour, utility, overhead, equipment, and process costs, and gives a partial sample of detailed estimate for a 6500-b.d. crude dist unit. M. F. M.

50. Cooling with ambient air. Pt II. E. C. Smith. *Petrol. Times*, 29.8.58, **62** (1595), 728.—The equations for performance regarding air-cooled heat exchangers are discussed and analysed. G. A. C.

51. Easy way to optimum heat exchanger design. J. Happel. *Chem. Engng*, 1958, **65** (18), 135.—Novel and handy equations have been developed to give optimum heat exchange design in an easy way in terms of terminal temp. For heat exchangers the economic balance is based on the optimum terminal temp. It is assumed that tube dimensions are specified and the overall heat transfer coeff is known. The equation given is in the form:

$$Qe = \underbrace{\frac{QH_tY8770}{1{,}000{,}000}} - \underbrace{rEA + rCi}$$

Qe is the operating earnings per year, the first part of the right-hand side of equation is the value of heat recovered, and the second part cost of recovery. M. F. M.

52. Biological treatment of phenolic effluent. Anon. *Petroleum, Lond.*, 1958, **11** (7), 233–5.—Some of the methods used by Canadian refineries to deal with phenolic effluents are considered. Apart from the orthodox biological oxidn method, one or two other methods have been tried.

Canadian Oil Companies Ltd have tried various combinations of four different methods since the autumn of 1953. These have included the injection of phenolic water in the cat cracking unit regenerator, evaporation in the cat cracking unit flue gas stack, injection as desalting water into the crude oil desalting system, and stripping with steam and flue gas followed by biological oxidn. P. D. E.

DISTILLATION

53. Pressure drop through bubble caps. H. T. Welch. *Petrol. Refin.*, 1958, **37** (8), 127–32.—An accurate prediction of pressure drop is essential to the design of a bubble cap tray. Directly dependent on this prediction are factors which include reboiler operating pressure and temp, the liq ht of the downcomer, and the vapour distribution ratio criterion of a stable tray. In order to provide a convenient and rapid method of calculation, the author has put the equations for the pressure drop through the various parts of the cap into simplified form. The subsequent steps involved, together with a new correlation for the aeration factor, are discussed in detail and a sample calculation given. P. H.

54. Instrumentation and control of distillation columns. T. J. Williams. *Industr. Engng Chem.*, 1958, **50** (9), Part I, 1214–22.—New techniques of feedback control and associated mathematical and computer treatments of the dist process have provided a theoretical basis for many practices. These studies indicate several new procedures or very desirable changes in present methods of control.

There have been recent important developments in instrumental methods of analysis. The resultant direct and rapid measurement of composition, rather than the previous measurement of environment, influenced properties such as temp, and furthers those methods of control prescribed as a result of theoretical studies.

From theoretical considerations an optimum control arrangement has been developed for a dist column, and the results of theoretical studies have been used to list recommended practices for the automatic control of a column.

Recommendations for a good dist column control are as follows: for max flexibility, primary column control should maintain boil-up rate–feed rate ratio and overhead composition constant. Sampling the top plate will give the best control. The rate control mode or derivative control is ineffective for dist column control. M. F. M.

55. The enrichment and depletion factor method in calculating multi-unit distillation and absorption columns. C. Mustacchi and R. Passino. *Riv. Combust.*, 1958, **12** (7–8), 581–94.—The advantages of the method are illustrated and a summary given of the criteria suggested by different authors for its application.

The analytical relationships of this method are used, together with material balances, to develop a system of equations which, once resolved, reveal the distribution of each component at the different points of a column.

Appropriate diagrams are given, by the use of which a quick calculation can be made of the fractions absorbed and of those stripped according to the number of disk plates and the absorption and depletion factors at the ends of a column.

(Authors' abstract.)

CRACKING

56. Hydrocracking an aromatic extract to naphthalene and 100 octane gasoline. A. K. Roebuck and B. L. Evering. *Industr. Engng Chem.*, 1958, **50** (8), 1135–8.—Light cat cycle oil can be separated by extraction with sulphur dioxide into a raffinate containing paraffins and naphthenes and an extract containing aromatics and sulphur cpds. Hydrocracking the extract can produce 16% naphthalene and 55% of 100 octane gasoline in a single step. The preferred extract contains 90% aromatics and boils in the 200°–250° C range.

Most active cat are alkalized chromia, vanadia, and cobalt–molybdenum oxides of alumina. Best conditions for hydrocracking with alkalized chromia–alumina cat are 525° C, 800 p.s.i., and a hydrogen–hydrocarbon ratio of 300 cu. ft/brl.

The gasoline produced contains 90% aromatics and less than 0·1% sulphur. M. F. M.

HYDROGENATION

57. Hydrogenation converts heavy oil to fuel gas. Anon. *Chem. Engng*, 1958, **65** (17), 64–6.—The Gas Council's new hydrogenator plant in Solihull, in which fuel oil is converted to fuel gas, is described. On the basis of Solihull operation the cost of production will be equal to or cheaper than the cost for conventional gas manufacturing. This will depend on the size of the plant. Basic reasons for economy of process are high overall thermal efficiency (typical thermal efficiency of hydrogenation stage is 95%) and valuable aromatic by-products (*i.e.* benzene, 10–12% by wt). Although operating at up to 1000 p.s.i., process does not use oxygen and it produces a gas of low toxicity. Process can be adopted for feeds ranging from low grade coal to light dist. The Solihull plant, however, is designed for crude oil or heavy fuel oil feedstocks. M. F. M.

58. Hydrogenation of aromatic hydrocarbons in oil derivates. II. D. Vranjican, S. Jurjasevic, and B. Prohaska. *Nafta (Yugoslavia)*, 1958, **9** (4–5), 95–8.—This part deals with the use of Raney-Ni and Mo oxide as cat for hydrogenation of aromatic concentrates.

In a series of experiments it has been established that the single use of these cat is not useful for quantitative hydrogenation in order to accomplish a direct method of structural group analysis. For this purpose a combination of these cat is recommended, as has been established in the authors' work concerning heavier petroleum fractions.

Mo oxide can be used as cat in certain cases of industrial hydrogenation of such aromatic concentrates.

(Authors' abstract.)

POLYMERIZATION

59. Polymerization. A. F. Roche and F. H. Bolton. *Industr. Engng Chem.*, 1958, **50** (9), Part II, 1393–401.—This article is an annual review and brings the knowledge of polymerization up to date.

In recent years highly important break-throughs in the polymerization process have taken place. In the past year these areas have been consolidated and expanded. A large number of publications have appeared during the year on stereospecific catalysis, and because of their importance all publications on this subject have been cited. Numerous specific cat were described, and for the first time elastomeric copolymers of ethylene and propylene were disclosed.

Linear high-density polyethylene, hitherto produced by heterogeneous cat, can be made in a high pressure free-radical process. Du Pont has obtained an important composition of matter patent on this material.

Graft copolymers have not yet attained commercial production. The use of radiation as an initiator and in preparation of graft copolymers is similarly promising but as yet commercially unexploited.

Important new polymers included a polycarbonate, a high mol. wt. polyethylene oxide, and a vinylidene fluoride-hexafluoropropylene elastomer. M. F. M.

ALKYLATION

60. Alkylation. L. F. Albright and R. N. Shreve. *Industr. Engng Chem.*, 1958, **50** (9), Part II, 1318–28.—During 1957 alkylate capacity increased from 280,000 b.d. and 3·2% of the crude vol to 313,000 b.d. and 3·5% of the crude vol. The increase of alkylate capacity in 1958 will probably be about twice that of 1957.

Process modifications have been reported to improve the economic position of the hydrogen fluoride alkylation process for gasoline blending. Consequently an increasingly larger share of new installations are hydrogen fluoride units. Simplification of reactor design and fractionation reduces capital and operating costs below those of sulphuric acid plants designed for production of equal quality of alkylate.

Several companies (Shell, Kellogg, and UOP) have announced new techniques for isomerizing butane and higher alkanes to *iso*butane and higher *iso*paraffins. The UOP process Butamer is reported to produce *iso*butane for 3 cents/gal. UOP has also recently announced a process for alkylating benzene using a cracked gas stream containing ethylene, propylene, and butylenes in low concn.

The alkyl aryl sulphonates have fallen from their peak of *ca* 80% of the synthetic detergent production to *ca* 50%. They have been replaced to a large extent by non-ionic cpds in the production of fluid detergents.

Recent books describe numerous methods of alkylating metal or metallic cpds and discuss the chemistry of the cpds formed. Considerable research is being done in this field, much of it on a restricted or secret basis. In this category are investigations of boron chemicals such as alkyl borones and alkyl boric acids.

A new plant in Carrolton (Kentucky) will be the world's largest for production of organotin cpds.

Subjects covered by the review include carbon–carbon aliphatic alkylation, alkylation with alkyl halides, carbon–carbon aromatic alkylation, carbon–nitrogen alkylation, carbon–sulphur alkylation, and carbon–metal alkylation processes. M. F. M.

61. From natural to super premium gasoline. R. E. Sutherland and D. H. Belden. *Petrol. Refin.*, 1958, **37** (7), 119–23.—The authors show that a " super premium " motor fuel can be made from natural gas liq, having overall quality characteristics which are out of reach of most refineries. The economic case for using natural gas liq, such as propane, normal butane, and *iso*butane, is extensively discussed in terms of future production figures. A flow scheme and processing details complete the survey. Lab tests on the resultant motor fuel are presented in tabulated form, and the authors point out that a far superior type of motor fuel has been produced. P. H.

62. Production of aromatics by hydrodealkylation. S. R. Bethea *et al.* *Industr. Engng Chem.*, 1958, **50** (9), Part I, 1245–52.—Toluene, C_8 aromatics, and the aromatics in kerosine extracts have been thermally hydrodealkylated to produce benzene and naphthalene with little degradation of the aromatic ring, when either cyl hydrogen or cat reformer tail gas was used.

The temp of the highly exothermic reaction may be controlled by the use of a bed of fluidized solids.

Benzene of 95–99% purity and the 78° C m.p. grade of naphthalene are easily produced by dist of the hydrodealkylated product. Refined grade naphthalene of 79° C m.p. can be made by precise fractionation. M. F. M.

CHEMICAL AND PHYSICAL REFINING

63. Three ways to purify gas. F. Zapffe. *Oil Gas J.*, 8.9.58, **56** (36), 100.—Amine, iron sponge, and the recent hot potassium carbonate processes are compared, outstanding features and economics discussed, and criteria which dictate the process to be used in a given situation indicated.

G. A. C.

64. The economics of acid-gas removal by the hot carbonate method. A. G. Eickmeyer. *Oil Gas J.*, 22.9.58, **56** (38), 106.—Heat exchangers are not required, less steam generation is necessary, and less cooling equipment, factors which under favourable conditions of pressure and acid gas content make initial investment in operating costs of a hot-carbonate plant considerably less than for an amine plant. G. A. C.

SPECIAL PROCESSES

65. A new commercial separation tool. R. C. Binning and F. E. James. *Petrol. Engr*, 1958, **30** (6), C14.—For some years, American Oil Co. has been investigating permeation as a means for separating liq mixtures. This has led to the development of a general separation technique which should find application in both petroleum refinery and chemical plant problems.

As an example of the use of this process, a design for a commercial installation charging 15,600 lb/day of a ternary azeotrope has been made. The feed mixture considered is a ternary azeotrope of *iso*propanol, ethanol, and water obtained as overhead product from a dist column. Membrane permea-

tion is shown to be far more economical than the use of "hexane azeotroping" for drying the feed mixture to a saleable product. P. D. E.

METERING AND CONTROL

66. Electro-hydraulic control—how well does it work? C. D. Gingrich. *Petrol. Engr*, 1958, **30** (9), C6–10.—This is a full report on how Regent Refining (Canada) Ltd decided upon the application of an all-electronic instrumentation system to a fluid cat cracking unit. The article describes how the system works and how the cost of installation and operation compares with other systems. The operation of an electro-hydraulic control loop is also described. It is stated, on the basis of experience gained at Regent's refinery, that electronic instrumentation is generally superior in performance, provided a reliable source of electrical power (constant voltage and frequency) is available at all times. M. F. M.

PRODUCTS

CHEMISTRY AND PHYSICS

67. Use of molecular sieves in gas chromatography for the determination of the normal paraffins in petroleum fractions. B. T. Whitham. *Nature, Lond.*, 1958, **182**, 391.—Synthetic zeolites can be used to determine the *n*-paraffins in kerosines and gas oils. The saturated fraction is separated by normal liq–solid chromatography, and a portion is passed through a gas chromatographic column packed with firebrick coated with a silicone grease. A second portion is run through the same column fitted with a pre-column containing zeolite coated with squalene. The difference between the areas of the chromatograms is a measure of the *n*-paraffin content of the fraction, and the amount of individual *n*-paraffins is obtained from the difference in areas at the individual *n*-paraffin elution times on the chromatogram. Results have also been obtained with waxes containing *n*-paraffins up to C_{40} using N_2 as carrier gas, tailing being reduced by operating the pre-column at 320° C and the main column at 270°–300° C. H. C. E.

68. Density of acetylene. G. A. Bottomley, C. G. Reeves, and G. H. F. Seiflow. *Nature, Lond.*, 1958, **182**, 596.—First the pressure–vol (PV) relationship was measured at $50 < P < 230$ mm, and the second virial coeff (B) was obtained from the slope of the PV/P graph. Then the density (d) was obtained from the expression $d = MP/(RT + BP)$, where M is the mol. wt. of acetylene. Extrapolating to $P = 760$ mm, d at 0°, 20°, 40° C is found to be $1{\cdot}1716_7$, $1{\cdot}0895_9$, $1{\cdot}0185_8$ g/l respectively.

Reasons are given for accepting the validity of the linear extrapolation of P. The method has the following advantages over that of direct determination: (1) comparative insensitivity to impurities; (2) pressure measurements are needed to an accuracy of only 0·1%. H. C. E.

69. Spherical apparatus for measuring the thermal conductivity of liquids. V. E. Schrock and E. S. Starkman. *Rev. Sci. Instrum.*, 1958, **29**, 625–9.—This thin-film spherical conduction apparatus was designed and constructed for use with relatively viscous liq. Errors due to convective heat transfer are negligible, and the absolute accuracy of measurements is believed to be within 2%. Results are given for a light (10·32 cS at 100° F) and a heavy (164 cS at 100° F) oil between the temp −100° and +70° F. H. C. E.

ANALYSIS AND TESTING

70. Mass spectrometric observation of ions in hydrocarbon flames. R. F. Knewstubb and T. M. Sugden. *Nature, Lond.*, 1958, **181** (4618), 1261.—The authors have constructed an apparatus for studying the nature and origin of ionized particles in the reaction zone of premixed hydrocarbon flames. Ions are mainly those of hydrocarbon molecules and radicals formed by rapid polymerization in the preheating zone, which is greatest for unsaturated fuels. The form of a typical spectrum of an acetylene/oxygen/nitrogen flame is shown and discussed. E. M. I.

71. A new way to determine chlorides in charge to catalytic reformer. C. Petty and R. Kung. *Oil Gas J.*, 25.8.58, **56** (34), 94.—If the concn of organic chlorides in the reformer charge is too high, serious reformer cat damage and production loss can occur. Method involves use of dist and titration of sample based on ASTM D1317–54T procedure. G. A. C.

72. The interpretation of the results of impulse breakdown tests. R. Hancox. *Proc. Inst. Elec. Engrs Monograph*, Sept. 1958 (Pt C), 404–6.—The paper considers a high-voltage, impulse-breakdown test procedure of a type often used in testing transformer oils, consisting of a series of impulses of increasing magnitude leading to breakdown. The results expected from such a test are compared with the variation with voltage of the probability of breakdown. R. T. T. B.

73. The breakdown of transformer oil under impulse voltages. R. Hancox and H. Tropper. *Proc. Inst. Elec. Engrs*, June 1958, 250–7.—The breakdown strength of filtered and partially degassed transformer oil under microsecond duration impulse voltages was found to be dependent on the voltage duration, the method in which the impulse was applied, and the electrodes used. The strength varied as the test proceeded. Oil impurities and the presence of microscopic gas bubbles were found to be important variables. R. T. T. B.

CRUDE OIL

74. An Overhauser effect in natural crude oil. Anon. *Nature, Lond.*, 1958, **182** (4642), 1087.—A negative Overhauser interaction, which occurs between the dissolved asphaltene-free radicals and the hydrogen protons of the lighter hydrocarbons, has been discovered in crude oil. Observations and calculations give the diffusion constant of the oil, distance travelled by a typical proton, and show that the large asphaltene radical is as effective in polarizing the adjacent fluid protons as smaller radicals. E. M. I.

75. Measurement of crude oil wetting tendencies. H. N. Dunning and R. T. Johansen. *Petrol. Engr*, 1958, **30** (7), B26.—Imbibition and the more general phenomena of capillary pressure afford the most direct approach to the measurement of wettability. The simplest type of capillary pressure observations involve the use of an interfacial tension capillarimeter. Such instruments have been used extensively in some academic lab, but have not found application in petroleum lab, mainly because they do not produce separate values of either interfacial tension or contact angle. However, it is considered that these quantities do not have independent significance in reservoir engineering and that the property of wettability they are intended to evaluate is given immediately by capillarimetric measurements.

The instrument is being developed as a method for screening reverse wetting additives for water block removal. The method should also prove a definite means of evaluating the wetting tendencies of various crudes. P. D. E.

GAS

76. Use this chart for water content of natural gases. J. J. McKetta and A. H. Wehe. *Petrol. Refin.*, 1958, **37** (8), 153–4.—The authors present a chart for determining the water content of various natural gases. Details of the data used to develop the chart are given, and corrections for different gravities and salinities are available. A sample calculation shows that the chart gives results comparable to those obtained by experimental techniques. P. H.

ENGINE FUELS

77. Using C_8 aromatics to get octanes? D. V. Trew and J. W. Howells. *Petrol. Refin.*, 1958, **37** (7), 137–9.—The authors give details of the blending characteristics of pure C_8 aromatics in conventional refinery stocks. The refinery stocks in which these aromatics were blended were light propylene alkylate fraction, virgin naphtha, light cat gasoline, and a blend of light high octane gasoline. Lab analyses of these blending components are given. It is concluded that of all the C_8 aromatics, orthoxylene is the least desirable in blending, and in all cases blends with light cat gasoline resulted in a blending depreciation. P. H.

78. Octane numbers. K. Arter. *Auto. Engr*, 1958, **48** (9), 338–40.—The development of lab and road rating methods from 1920. Conditions of ASTM Lab and Motor Method of assessing O.N. are given and sensitivity defined. Necessity to extend scale beyond 100 O.N. meant new scale—performance numbers, used for aviation fuels, using TEL in *iso*octane as ref. fuel. Motor fuels above 100 O.N. are calculated empirically from performance No. The Uniontown and Modified Borderline road test methods described give performance of fuel on road. E. M. I.

79. This new additive can boost octane. R. J. Riggs *et al.* *Petrol. Refin.*, 1958, **37** (7), 131–6.—The authors give details of a new organometallic anti-knock additive, methyl *cyclo*pentadienyl manganese tricarbonyl. The anti-knock effectiveness of the new additive is illustrated first by showing its response in selected hydrocarbons. Results show that the greatest response is observed in the paraffins and naphthenes, with aromatics responding the least. The most important use of the additive may be as a supplement to TEL. Comparative data are presented to show its effect in selected hydrocarbons when TEL is present. Information is also given on its use in a number of blends containing natural gasoline and on its effectiveness in increasing the O.N. of isomerized stocks. P. H.

GAS OIL AND FUEL OIL

80. Practical experience with the use of heavy fuel oil in medium speed industrial diesel engines, operated by the State Electricity Commission of Victoria. R. P. Kay and D. C. Cooper. *Trans. Inst. Mar. Engrs*, 1958, **70** (9), 281–92.—This paper deals with the fundamental principles in using fuel oil in Mirrlees and Clark Sulzer diesel generating plant in three power stations. Experience on the preparation; storage and handling; visc and injection characteristics; effect of lub oil on performance; deposits and wear on valves, piston, and liners is given. Engine modifications and economics are discussed and conclusions drawn. E. M. I.

81. The glass effect on distillate fuel oil stability. J. G. Christian *et al.* *Industr. Engng Chem.*, 1958, **50** (8), 1153–6.—Glass containers are often used for storing fuels during stability studies. The nature of glass has a pronounced effect on the rate of degradation of some dist fuels.

Of 13 fuels studied, ten degraded less rapidly in soft glass than in borosilicate glass, while three fuels showed no difference. Treating the bottles with strong acid or alkali before use caused only minor changes in degradation rates.

The glass effect, when operative, is due to inhibition by soft glass and not to acceleration by borosilicate glass. Because borosilicate containers appear to be essentially inert, they should be better for fuel stability studies than soft glass containers. M. F. M.

82. Structural composition of gas oils from Italian crudes. A. Girelli and C. A. Fratta. *Riv. Combust.*, 1958, **12** (6), 463–73.—The structural composition was determined of gas oils distilled from Italian crude oils of particular interest to the national petroleum industry: Ragusa, Alanno (Cigno No. 1 well), and Cortemaggiore. The composition was compared with that of two gas oils from Aramco (Middle East) and Bachaquero (Venezuela) crude oils chosen for their characteristic structure: the first paraffinic, the second aromatic-naphthenic.

The study was performed on the different gas oils, previously fractionated, with the *n–d–V* method in the modified version of Cornelissen and Waterman. Results are expressed as percentage of carbon in the various structures and as mean number of aromatic and naphthenic rings per mol.

(Authors' abstract.)

LUBRICANTS

83. Piston ring wear. J. H. Deterding and J. R. B. Calow. *Auto. Engr*, 1958, **48** (10), 378–81.—This paper describes the apparatus fitted to a Standard Vanguard car to measure the piston ring wear of moving vehicles by use of radioactive tracers. Two rings are irradiated, the wear products being carried away by the lub oil, which is drawn from the sump and circulated through a counting cell. Details of the system and some results are given. The apparatus has been used for evaluation of lub oils. E. M. I.

84. Duration of efficiency of a dispersant additive in a contaminated lubricating oil. G. Costantinides and S. Rotteri. *Riv. Combust.*, 1958, **12** (6), 474–93.—The authors suggest a new, simple method of both evaluating the detergent capacity of a new lub oil and following up the behaviour of this property in use on diesel engines, irrespective of the fact that degradation may be due to oxidn phenomena or contamination by carbon black. An extension of the method also indicates what point in the lubricant's useful life has been reached at any given moment. (Authors' abstract.)

85. Axle lubrication. Anon. *Auto. Engr*, 1958, **48** (9), 340.—Research by London Transport shows use of castor oil for rear axle lubrication improves fuel consumption by 2–3%. Higher cost is insignificant, and gumming is overcome by use of oxidn inhibitor. Use of thinner oils did not improve consumption. E. M. I.

86. Lubrication in the nuclear age. C. G. Williams. *Inst. Petrol. Rev.*, 1958, **12** (143), 365–7; *Petrol. Times*, 26.9.58, **62** (1595), 805.—Extracts from the paper given at the 120th Annual Meeting of the British Association, Glasgow, 1958, deal with lubrication of circulating fans, control-rod operating mechanism, and lubricating problems involved in developing products to withstand the deleterious effects of nuclear radiation. G. A. C.

87. Emulsion cylinder oil cuts maintenance of a trawler by £300 a year. A. G. Boyden. *Trans. Inst. Mar. Engrs*, Aug. 1958, **70** (8), 267–70.—Trials of emulsion type cyl lubricant in

two vessels powered by loop scavenged, two-stroke diesel engines using conventional crankcase oils. Beneficial results are reduced liner wear, reduced piston ring wear, longer periods between overhaul, and protection against acidic corrosion within the crankcase. Graphs of liner wear (chromium plated and cast iron), analysis of crankcase oil, and lub oil consumption are given. E. M. I.

BITUMEN, ASPHALT, AND TAR

88. Bituminous pavement coverings according to the Compomac process. (In German.) K. Raschig. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (6), 210–14.—The Compomac process is described with numerous photographic illustrations. Advantages claimed for the bituminous covering are: noiseless but not glazed surfaces; safe for traffic; rapid laying; prespraying with binder is unnecessary; no time is lost through bad weather; rapid progress with little delay to traffic; economy, since no time is lost by personnel and appliances. R. T.

SPECIAL HYDROCARBON PRODUCTS

89. High purity propylene. Anon. *Chem. Engng News*, 28.4.58, 34.—Newer uses require propylene of 99% purity, higher than usually made. Cost studies have been made on the purification of propylene by dist. The estimated current usage of propylene in various chemicals is given. R. T. T. B.

COAL, SHALE, AND PEAT

90. Pyrolysis of coal and shale. C. H. Prien and M. Perch. *Industr. Engng Chem.*, 1958, **50** (9), Part II, 1401–6.—This is an annual review of published literature. It shows that important work was done in England on the production of smokeless fuels, with significant development in continuous fluidized carbonization of coals. The literature reports increasing Russian activity in development of oil shale resources of both Estonia and U.S.S.R. Considerable effort is being expended in fundamental research on chemical characteristics of these shales and on the pyrolitic decomposition products. By contrast little research is being conducted on U.S. oil shales. There is some evidence, however, that shale oil costs are already competitive with U.S. petroleum.

Amongst other topics covered in this review are mechanism, kinetics, and thermochemistry of coal pyrolysis, low and high temp carbonization, oil shale pyrolysis, types of retorts, and shale oil by-products. M. F. M.

MISCELLANEOUS PRODUCTS

91. Polycyclic aromatic hydrocarbons in carbon blacks. A. J. Lindsay, M. A. Phillips, and D. S. Wilkinson. *Chem & Ind.*, 1958, 1365–6.—Three samples of C black were examined by extraction, Al_2O_3 chromatography, and determination of u.v. absorption spectra. Sample of American origin, which had been (on manufacture) extracted with C_6H_6, was almost free from polycyclic cpds; two European samples contained 12·97 and 5·75% (wt) of these cpds, including in each case *ca* 1% of known carcinogens; detailed analyses given. W. A. M.

CORROSION

92. Reducing cathodic protection costs in tankers. L. R. Page. *Corrosion Tech.*, 1958, **5**, 257–9.—The tendency exists in the shipping industry—due to low freights—to economize in marine corrosion control, particularly in cathodic protection. In expert hands cathodic protection—generally 80–86%—may be maintained with modified anode sizes, area/wt ratios, anode disposition and installation details, and sometimes protective criteria. Untried systems based solely on financial limitations cannot be guaranteed as an economic proposition. Combined eff and economy are reported with a finned anode containing 85 lb Mg. A special attachment is described and complete protection is given for 3–4 yr. Larger anodes may weigh 127 lb. Epoxy resin paints are satisfactory for corrosion prevention, but minor breakdowns in the film produce severe localized corrosion. A combined painting and cathodic protection would be an ideal solution to the corrosion problem but would be uneconomical for a life of <15–20 yr. Mg anodes tend to promote paint stripping from hulls in salt water. Zn anodes are more effective for hulls, propellers, and rudders. R. T.

93. Plastic coatings for buried pipes. W. D. Parker. *Corrosion Tech*, 1958, **5**, 179–80.—Among films developed from synthetic resins, polyethylene and PVC alone qualify for incorporation in a protective coating for buried pipes. PVC film is used more commonly as a backing, since adhesion difficulties with polyethylene still have not been overcome. Various factors limit the protection given by PVC pressure-sensitive tapes. Unplasticized film is very strong, with a v.p. coeff only 50% > polyethylene, but its rigidity prevents wrapping of films > *ca* 0·0015 inch. Cold flow to which PVC is subject relaxes the tension in the pipe wrapping necessary to prevent access of corrosive media to the metal surface. "Densopol" incorporates the standard petrolatum matrix impregnated and coated on a glass fibre tissue carrier, with a backing of PVC film. The "Denso" matrix contains selected tannins to counteract the action of anærobic sulphate-reducing bacteria. The PVC cpd incorporates non-migratory plasticizers. "Densopol" is finding increasing use in oil, gas, and water pipeline protection. R. T.

94. Design and installation of cathodic protection. Pt 1. N. P. Peifer. *Pipe Line News*, 1958, **30** (9), 42–9.—The paper surveys the underground corrosion of pipes and presents the various factors which determine the need for cathodic protection, the current required, cathodic interference to other underground structures, and the cost of cathodic protection installations. Corrosion survey sheets and a number of other useful diagrams are included in the paper. M. F. M.

ENGINES AND AUTOMOTIVE EQUIPMENT

95. Recent engine developments in relation to fuels and lubricants. D. Downs. *J. Inst. Petrol.*, 1958, **44** (414), 147–60.—Higher C.R. is the main development in the spark ignition engine. This requires fuels with higher TEL content, which have greater sensitivity to combustion chamber deposits and greater tendency to pre-ignition. Advantages of petrol injection are given and two systems of it described. The author next gives the fundamental differences between gasoline and diesel engines and states that the main development in the diesel engine is the introduction of small and supercharged diesels, which he describes, with discussion of their fuel and lubricating requirements. He points out the advantages of using gas turbine and free piston engines in various industrial applications, including aircraft, power plants, and road vehicles. In concluding, he indicates how the new improved lubricants are overcoming the problems created in the lubricating field. 7 pp. discussion.

E. M. I.

MISCELLANEOUS

96. New metals in the oil industry. Pt 1. W. H. L. Hooper. *Petroleum, Lond.*, 1958, **11** (7), 219–24.—Of the dozen or so new metals on which production has started on a commercial scale during the past 15 years, four metals are outstanding for their almost complete inertness to a wide range of corrosive media. These are titanium, zirconium, tantalum, and niobium. Part 1 deals mainly with titanium and zirconium, and their properties are reviewed from the viewpoint of the petroleum equipment manufacturer.

At the present time titanium is significantly cheaper than the other metals, and extensive data are given on the behaviour of titanium in a large number of standard lab and typical process chemicals. Data are also presented on the physical properties of these metals, with particular reference to their low mechanical strength at elevated temp.

To complete a comprehensive review the welding, forming, and manipulation of the metal are discussed. P. D. E.

97. Applied hydrocarbon thermodynamics. Pt 7. Isentropic exponents for gases. W. C. Edmister. *Petrol. Refin.*, 1958, **37** (7), 153–62.—Temp changes and work calculations for adiabatic compression or expansion of gases may be made in any one of three ways, all assuming reversibility. The Mollier chart and entropy balance methods are summarized by the author before dealing in detail with the isentropic exponent method. The theory of this method is developed extensively using exponents defining temp and vol changes with pressure for the gas. Then the final temp and work are computed by simple equations. Generalized charts for isentropic exponents are presented along with all the necessary thermodynamic properties of gases for these calculations.

P. H.

98. Applied hydrocarbon thermodynamics. Pt 8. Polytropic compression and expansion. W. C. Edmister. *Petrol. Refin.*, 1958, **37** (8), 113–22.—If heat is added or removed during the compression or expansion of a gas, the resulting path is called polytropic to distinguish it from the adiabatic path. Adiabatic and polytropic processes may be reversible or non-reversible. The author develops a calculation method for estimating the final temp for polytropic compression and expansion of gases, where no Mollier charts exist. The steps involved are discussed systematically, and the relevant plots are given in detail. Deviations from reversibility are not covered by the method, and the application concerns only reversible polytropic processes. P. H.

99. What you should know to design a compressor foundation. W. F. Swiger. *Petrol. Engr*, 1958, **30** (9), D23–27.—In the design of compressor foundation consideration should be given to: (1) behaviour of soil under static and vibrational loads; (2) magnitude and effects of soil distortions; (3) means of limiting vibration; and (4) possibilities of deterioration or distortion of the foundation. Special attention has been paid in the paper to the problems connected with pile foundations, resonant frequency, and the determination of mass of compressor foundation. M. F. M.

100. Nickel and cobalt catalysts in the petroleum industry. Pt 2. P. D. Wilmot. *Petroleum, Lond.*, 1958, **11** (7), 225–8.—Cat formation of hydrocarbons was discussed in Pt 1. Pt 2 deals mainly with the major field of application, namely, processes involving hydrogen.

The mechanisms for hydrogenation, partial hydrogenation, isomerization, desulphurization, and dehydrogenation are dealt with, and the merits of particular cat for specific reactions are discussed. P. D. E.

101. Third International Hydrocarbon Convention at Piacenza. Anon. *Petrol. Times*, 10.10.58, **62** (1596), 832.—The Convention and Seventh National Methane Exhibition is reported. Subjects included development of petroleum chemicals industry, use of national gas in Vetrocoke plants, sea transport of natural and liquefied petroleum gases, gas from Laca for the chemical industry, commercial uses of methane, and cat cracking of natural gas. G. A. C.

102. Petroleum legislation in India. Anon. *Petrol. Times*, 29.8.58, **62** (1593), 733.—A review is given of recent legislation relating to the petroleum industry in India, and includes matters such as exploration, exploitation, and refining of oil. G. A. C.

103. New petroleum legislation in Spain. Anon. *Petrol. Times*, 26.9.58, **62** (1595), 801.—The new law will regulate exploration and production, and make possible entry of foreign capital and technical knowledge into Spain, the Balearic and Canary Islands, and Spanish Guinea and Spanish West Africa. A review is given regarding general terms, exploration permits, exploitation concessions, authorization to refine, store, and transport, and taxation. G. A. C.

BOOK REVIEWS

Phase Relations of Gas-condensate Fluids. C. Kenneth Eilerts *et al.* New York: American Gas Association, 1957. Pp. xxiii + 439. $10.00.

This book is the first of two volumes and represents the results of more than twenty years research carried out under the auspices of the U.S. Bureau of Mines and the American Gas Association in the phase behaviour of natural gas condensate fluids. In the early stages of the project oils and natural gases were to be studied, but the scope of the investigation was narrowed down to gas condensates only, owing to industrial interest, which had been stimulated by the recent innovation of gas cycling. It is expected that the data will be of great use to the engineers involved in production from gas condensate reservoirs, as it includes standard tests which can be used in conjunction with the correlation diagrams to indicate the phase boundary properties. These properties are of prime importance because retrograde condensation may occur with gas condensates and can lead to the loss of a large proportion of fluid due to condensation of a liquid phase in the reservoir as the recovery process proceeds.

The monograph commences with details of known natural gas reserves in the U.S.A. and indicates that gas condensates make up 25 per cent of these reserves. The results of a survey of wells producing by cycling is given, with the respective liquid–gas ratios obtained. This is followed by an introduction to the phase diagrams of gas condensates and their differences from pure components from the point of view of pressure, volume, and temperature relationships. A method is given for calculating the distribution of components in the phases of a fluid from vapour–liquid equilibrium ratios, and the construction of the phase diagram, from the measurement of liquid–gas ratios over a range of temperatures and pressures, is illustrated.

The critical state constants are useful in the solution of phase relationship problems, and a simple method of obtaining the critical temperature and pressure can therefore prove very useful. The data available in the literature on two-component systems was used to test, and assist in the development of, correlations for the determination of these constants for multicomponent mixtures. The difference between the simple mixtures and natural gas condensate mixtures is overcome by the use of the concept of a liquid and gas component, in place of light and heavy components used for binary systems. The ratio of the measured critical constant to the molal average critical constant is used to provide a dimensionless function for correlation. The normal boiling point of the constituents is used as a weighting coefficient to emphasize the effect of the heavy components in the calculations.

A similar correlation is utilized for the computation of the cricondenbar pressure, the reference functions on the correlation diagrams being the ratio of measured cricondenbar pressure to either molal average critical pressure or molal average cricondenbar pressure. The latter requires knowledge of cricondenbar pressure of the constituent phases, but the first requires only composition.

A description is given of the apparatus, and the tests made with a mobile laboratory on a series of light gas condensate wells. In general, the types of tests made were: (1) with the well shut in, in order to determine formation temperature and pressure; (2) with stabilized well flow, to obtain representative flow samples; (3) with the mobile lab equipment. This equipment consisted essentially of an accumulator to simulate the well head separator and thus separate the liquid phase from the flowing fluid at constant temperature and pressure, and also to act as a reservoir for the liquid phase; a liquid stabilizer is used to simulate stock tank conditions. Thus, this assembly served the same functions as the full-scale equipment, but operated on a 1 per cent sample of the fluid flowing from the well. Particular stress is laid on the necessity of obtaining a representative sample of the well effluent, and the selection of the appropriate sampling rate influences this factor. The proper sampling rate was determined by finding experimentally the rate at which the accumulator liquid–gas ratio equalled the separator liquid–gas ratio at the same temperature and pressure.

The composition of all fluids was determined by low-temperature distillation, which was carried out in two stages—the first at atmospheric pressure, the second at the reduced pressure of 40 mm Hg.

The results of the field tests and laboratory results—the latter included determinations of compressibility factor and the critical values of temperature and pressure using a windowed cell—for the gas condensate fluids used in the development of the correlations presented in earlier chapters are presented in the form of phase diagrams.

The various correlations in this work are particularly useful in that they are in dimensionless form and can therefore be used in any consistent set of units without resort to conversion factors; they provide a means of predicting the significant properties of fluids using the results of relatively simple tests. After each correlation an indication of the errors is given, and an estimate is made of the accuracy to be expected in application.

The monograph was developed for application to gas condensate problems, but it will probably be useful in any operation concerned with the mixing of gas and reservoir oil.

N. J. N.

Heat Exchangers—Applications to Gas Turbines. W. Hryniszak. London: Butterworths Scientific Publications; New York: Academic Press, 1958. Pp. xii + 343. 63*s*.

This book deals specifically with heat exchangers for gas turbine engines, although brief mention is made of the fact that there could be a similarity between heat exchangers for gas combustion turbines and a closed cycle gas turbine working in conjunction with a gas cooled nuclear reactor.

It is written by a specialist for specialists. In general, it makes a broad distinction between "recuperative" heat exchangers, which are defined for the purpose of the book as "heat conducting" (continuous flow) method, and "regenerative," where there is alternative heat charging and discharging (periodic flow) working. After describing the purpose and duties of heat exchangers in the various gas turbine cycles the principal thermodynamic properties of heat exchangers are dealt with and, to one who is not expert in the subject, it is made more difficult by the use of different symbols from those commonly used. For example, the symbol γ for the ratio of the specific heats of a gas is never used and is not listed, but a symbol Γ_m, which is $\frac{\gamma}{\gamma - 1}$, is introduced under the name adiabatic coefficient, and tables of this property are given.

Advanced methods of assessing heat transfer rates are given for the various kinds of heat exchange surfaces which are being developed, and methods of calculating the various pressure and temperature stresses imposed on heat exchange elements are described. Tables of high temperature properties of the high alloy materials used are included. Perhaps the most interesting parts of the book are those showing the many ingenious types of heat exchanger, re-

cuperative and regenerative, large and small, which have been devised and tested during the past decade to meet the requirements of high temperature heat exchange between gases whilst retaining low weight and reasonable overall dimensions. W. P.

Automatic Measurement of Quality in Process Plant. Proceedings of a Conference held at Swansea 23–26 Sept. 1957 by the Society of Instrument Technology. London: Butterworths Scientific Publications; New York: Academic Press, 1958. Pp. xi + 320. 50*s*.

This book comprises the collected papers read at the Swansea Conference on Quality Measuring Instruments; it brings together contributions, both to the papers and the subsequent discussions, from experts in all quarters of industry. These contributions are almost all of a very practical nature, relating to equipment which has been tried and tested.

Papers are included dealing with semi-automatic laboratory apparatus with which an operator can conduct several simultaneous determinations, each with an accuracy which would be difficult to achieve manually even if the analyses were conducted sequentially.

This work leads naturally to that on completely automatic instruments. Some of these are " automatic chemical laboratories " reliably carrying out complex conventional analytical procedures. Others are based on essentially physical techniques, measuring the desired variable directly, as with viscometers, or inferentially, as with the determination of chemical composition from infra-red absorption.

It is evident that the reliability of these instruments is continually increasing and their maintenance being simplified so that the major part can be done by instrument mechanics.

Throughout the book there are numerous references to the need for well-designed sampling systems and one excellent paper is devoted to this subject, which has been neglected too often in the past.

Overall, this book constitutes a conspectus of modern trends in industrial analysis, and few who are interested in this field would fail to find it of value. D. M. R.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren " Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the " Library Catalogue " published by the Institute.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

104. Statistics on natural gas discoveries. F. H. Lahee. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (9), 2037–47.—The period of this report is decade 1943–52, and the area included is the "17-states area," which, within 5%, approximates the entire U.S.A. in wildcat drilling activity and in both oil and gas reserves and production.

10 tables accompany the report and a number of conclusions are drawn. The statistics show that the most realistic figures for success-to-failure ratios among new-field wildcats are 9·41%, *i.e.* one in every 10·62 drilled successful for both oil

and gas discoveries, or 9·28%, *i.e.* one in every 10·78 drilled successful for gas discoveries. E. N. T.

105. Geology and oil. A. H. Smout. *Nature, Lond.*, 1958, **182**, 832–4.—Report of a symposium held at Glasgow, Aug. 1958. The topics included the contribution of geology to the oil industry, geology and geophysics in oil exploration, the contribution of oil exploration to geology, theory and practice of microfacies work, and well-logging as guide to geological investigations. H. C. E.

106. Trends in exploration. F. H. Lahee. *Proc. Amer. Petrol. Inst.*, 1958, **37** (4), 38–52.—The success-to-failure ratio in the drilling of wells for oil or gas may be estimated at the end of the year of completion or of abandonment, or it may be estimated after a few years of development history. In the former case it is found, by a study of the statistics for the years 1944–45, inclusive, that the percentage of success for all wells drilled for oil or gas was 64·53; that the percentage for all exploratory holes, exclusive of field development wells, was 19·88; and that this percentage for new-field wildcats alone was 11·29. This last figure has been expressed as one success in nine wildcats drilled, a ratio frequently quoted from published articles.

After four or five years of development history, some of the wells (or fields discovered by them), thought at first to be commercial, turn out to be unprofitable, and so they are abandoned. Essentially these are failures. When their number is added to the number of dry new-field wildcats reported at the close of the year of completion, the result is a change in the success-to-failure from 1 in 9 to 1 in 10, or from 11·29 to 9·72%. The ratio of one successful new-field wildcat in every ten drilled is more correct and should be used in demonstrating the risks in wildcat drilling.

(Author's abstract.)

107. Geological research and the American Petroleum Institute. C. I. Alexander. *Proc. Amer. Petrol. Inst.*, 1957, **37** (6), 46–50.—This report reviews the scope of geological research supported by the API. Four of the first five fundamental research projects were geological studies in organic chemistry which attempted to find an answer to the question of the origin of oil and gas. Five other projects were strictly geological in nature, and two others contributed fundamental knowledge of earth properties or materials.

Each of the early projects resulted in bits of fundamental information upon which later workers have been able to build.

The currently active Project 51, "Study of Near-shore Sediments and their Environments in the Northern Gulf of Mexico," is the largest geological project ever sponsored by the Institute. This study of recent marine sediments includes the physical properties of the sediments, the relationship of marine life to the various sedimentary environments, and the organic productivity in different environments. Project 51 is making important direct contributions to our basic knowledge of sediments and sedimentary processes. This knowledge will be used to good advantage by oil exploration people to develop the new tools and techniques needed to find the oil and gas hidden in stratigraphic traps.

Under sponsorship of the Geological Domain Cttee, outstanding research workers from college and university geological departments are invited, at API expense, to participate in symposia on various aspects of fundamental geological research.

Through the various programmes, the API is playing an important part in the study of the structure and history of our planet. (Author's abstract.)

108. Observations on fusain. H. Skolnick. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (9), 2223–36.—Fusain, usually called carbonized wood or mineral charcoal, and probably constituting a large part of the "carbonaceous material" mentioned in lithologic descriptions, is a common constituent of sedimentary rocks and can be successfully used as a parameter in the interpretation of sedimentary environments associated with some of the stratigraphic-type oil pools.

As most of the ancient beach and bar deposits now in the subsurface bear little relation to the surface lithologic features or to surface structure, much of the exploration for these potential reservoirs can be done only with the drill. Char fusain requires special conditions of entrapment such as quick burial in active surf zones or accumulation in areas of slack water to result in fusain-rich sediments, conditions like those found along shore and nearshore areas such as beach, bar, bay, and lagoonal environments. However, fusain in quantity also occurs in coals, which are recognized as being terrestrial in origin rather than marine in most instances, but such association could be with lump resin, the stony coals, or both. The presence of pine tar, however, and the absence of lump resin and/or stony coals should strongly suggest char origin and therefore one of the sedimentary environments discussed. The investigator should attempt to augment his findings by using other geologic evidence, for in the final analysis the multiple working hypothesis is still the most powerful investigation tool. E. N. T.

109. The Mid-Continent—a land of geological opportunity. A. I. Levorsen. *World Oil*, 1958, **147** (4), 101.—Exploration has been carried out in the Mid-Continent region of the U.S.A. for over 50 years, and although very many oil and gas fields have been found, there remain large areas of promise which await development. Most of the oil comes from Palæozoic rocks, and every system has been found productive. Many different types of reservoir rock occur, and the accumulations are found in a variety of traps, unconformities being particularly important. A vast amount of information on the subsurface geology has become available, and it is one of the most valuable regions for studying the industry and practising petroleum geology. Maps and diagrams illustrate geological aspects of the area. C. A. F.

110. Differential entrapment of oil and gas in Arbuckle dolomite of Central Kansas. R. F. Walters. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (9), 2133–73.—In the Arbuckle gas and oilfields of Central Kansas, gas is present in the southwesternmost and structurally lowest traps; oil in step-like traps structurally higher, though some of the highest closed structures are salt-water bearing. This distribution affords the best evidence that gas and oil migrated long distances (more than 100 miles) N., spilling upward under an impervious roof of Ordovician or Pennsylvanian shale until trapped in the Cambro-Ordovician Arbuckle reservoirs. The time of migration and accumulation was mid-Permian. Pre-Cretaceous westward tilting caused local eastward remigration within the Central Kansas uplift; post-Cretaceous tilting resulted in readjustment within reservoirs. These conclusions best explain the present differential entrapment of gas and oil in the Arbuckle reservoirs of Central Kansas.

E. N. T.

111. Molas and associated formations in San Juan basin–Needle Mountains area, Southwestern Colorado. W. M. Merrill and R. M. Winar. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (9), 2107–32.—A review of some of the literature dealing with the Molas formation and its equivalents in the Four Corners area reveals differences of opinion about its age and historical significance. The writers studied and sampled exposures along the N. rim of the San Juan basin and in the Needle Mountains, SW. Colorado, and made petrographic, insoluble-residue, heavy-mineral, and clay-mineral (X-ray diffractometer) analyses of the samples.

The interpretation presented is that a residual deposit accumulated in SW. Colorado as solution of Mississippian and

Devonian limestones took place during post-Osage, pre-Pennsylvanian erosion. The upper part of the old regolith was eroded and deposited elsewhere by streams; some of it was finally deposited in and reworked by the advancing early Pennsylvanian sea. In some areas, deposition of the Molas red clastics continued into early Des Moines time.

E. N. T.

112. Pennsylvanian system of Four Corners region. S. A. Wengerd and M. L. Matheny. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (9), 2048–106.—Results of this investigation establish the existence of an important datum (the "P" datum) which is the top of the Paradox formation. This datum, over a great part of the region, is a disconformity which marks the end of Paradox penesaline deposition, and is a mappable surface critical in the evaluation of the sedimentational and structural history of the Paradox geosyncline.

As new drilling proceeds in the wildcat areas of the region, the Pennsylvanian system will need to be subdivided into smaller time-stratigraphic units which are correlative with practical lithic units here named, so that they can be used with confidence by geologists working in the Four Corners region.

The Paradox geosyncline, major ancient tectonic feature which controlled Pennsylvanian sedimentation in the Four Corners region, is located in Utah, Colorado, Arizona, and New Mexico. The basin of deposition, with its shelves and sediment-supplying tectonic highlands, covers almost 60,000 sq. miles.

E. N. T.

113. Gases in marine sediments. K. O. Emery and D. Hoggan. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (9), 2174–88.—Mass spectrometer analyses were made of gases extracted under vacuum from sediments of marshes and deep marine basins off S. California. The results show that gases other than oxygen, nitrogen, and argon are much more abundant in sediments than in the overlying water. Carbon dioxide and methane increase markedly with depth in the sediment, more or less paralleling the previously known increases of ammonia and hydrogen sulphide. Although data for them are less complete, ethane, butane, hexane plus, *iso*pentane, *cyclo*butane, *cyclo*pentane, benzene, and toluene also exhibit general increases with depth. Methane in sediments 124–148 inches deep at the bottom of the Santa Barbara basin weighs nearly as much as the total of all non-volatile heavy hydrocarbons in the sediment, thus providing a gas–oil ratio similar to that of oilfields. A very high methane–ethane ratio of the sediment gases contrasts with the low ratios in oilfields and indicates that further diagenesis is required before the sediment gases are like those in oilfields.

E. N. T.

114. Cooking Lake and Duvernay (Late Devonian) sedimentation in Edmonton area of Central Alberta, Canada. J. M. Andrichuk. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (9), 2189–222.—The Cooking Lake carbonates were deposited on a widespread Late Devonian bank that extended from S. Alberta to the Edmonton area of Central Alberta. A distinct bank margin existed directly W. of the present Leduc–Morinville reefs of Leduc age throughout Cooking Lake deposition, whereas in late Cooking Lake time a N. bank margin was developed N. of the Smoky Lake and Duvernay areas.

Detailed mapping of carbonate facies in the Cooking Lake represents a basic method of approach to Leduc reef exploration; in addition, the pattern of distribution of permeable and relatively non-permeable rocks in units such as the Cooking Lake may reveal areas favourable for entrapment of petroleum.

E. N. T.

115. Haiti has good oil and gas possibilities. A. H. Wadsworth. *World Oil*, 1958, **147** (4), 142.—There is active exploration in Haiti, where there are a number of basins favourable for oil and gas occurrence. Gravity and magnetic surveys have been carried out and a photogeological study is being undertaken. The structure and stratigraphy of the area are outlined. There are four sedimentary basins of interest: the Central Plateau basin, the Cul de Sac basin, the Artibonite basin, and the Cayes basin. Each contains Tertiary sediments and marine sections aggregate *ca* 26,000 ft. Facies are locally favourable with sands intercalated with marine shale. Opportunities for structural and stratigraphic trapping exist and there are oil and gas seeps in the Cul de Sac basin near the border with the Dominican Republic. A total of seven wells has been drilled in the country, and a few of these had shows. 10 refs.

C. A. F.

116. CREPS discoveries in the Sahara. P. Moch. *World Petrol.*, 1958, **29** (10), 61.—Recent oil discoveries in Algeria by CREPS are described. Following a photogeological survey, field work was carried out in 1954 and 1955 and the first wildcat drilled in Dec. 1955. This found oil at Edjele, and further wells found oil at Tiguentorine, Zarzaitine, and El Adeb Larache. These discoveries are in the Fort Polignac basin, which lies on the edge of the Hoggar, the central shield of the Sahara. 75% of the area is covered by sand dunes, but there are outcrops which permit structural mapping. The regional geology is outlined, together with brief descriptions of the geology of the fields. It is believed that Algeria will become a major source of oil for Europe.

C. A. F.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

117. Petroleum prospecting by microbiology. A. Luchter. *Petroleum, Lond.*, 1958, **11** (8), 282–6.—Microbiological prospecting is based on detection, by means of bacteria, of gaseous emanations which may seep through the soil from underlying petroleum deposits. Hydrocarbon-utilizing bacteria are widespread wherever gaseous hydrocarbons exist, *i.e.* in soil, rocks, and waters near oil or gas deposits. Attempts to develop a microbiological petroleum prospecting method have been made in the past both in the U.S.S.R. and in the U.S.A., but there are not many publications describing the application of the results of previous findings in practice.

The author's recent work (between 1951 and 1957) carried out in the Polish Petroleum Institute at Krakow is fully described. In the first stage a method of oil and gas prospecting based on "bacterial indices" was employed. After isolating 120 mixtures of hydrocarbon-consuming bacterial strains from samples of oil-producing areas, investigations were conducted to eliminate the most active cultures with a view to using them as "bacterial indices." Field investigations were then conducted and the results compared with those obtained in the lab.

In conclusion, it is emphasized that the microbiological method should be applied parallel with other geochemical survey methods.

M. F. M.

118. Sedimentary geochemistry. G. D. Nicholls. *Petroleum, Lond.*, 1958, **11** (9), 316–21.—The distribution of the chemical elements in sedimentary rocks is still not fully understood. The knowledge of the variation in the concn of minor elements in any one stratigraphical horizon is also lacking.

Since 1952 a group of geochemists, working at Manchester University, have been attempting to remedy this deficiency in our knowledge. The paper is the result of their work and publishes for the first time the lines along which this research has been directed. It is suggested that the prospects of evolving a geochemical method of strata correlation are encouraging, and they justify further investigation into the geochemistry of the sedimentary rocks.

M. F. M.

119. The geochemistry of uranium and lead-age-dating. W. J. Yost. *Proc. Amer. Petrol. Inst.*, 1957, **37** (6), 51–3.—Geologists need to determine the time which has elapsed since certain geological processes occurred. One effective method for making such time measurements depends on the radioactive decay of certain naturally occurring isotopes. Certain isotopes of uranium, thorium, potassium, and rubidium have been used to determine the dates of certain igneous and metamorphic processes. In order to obtain more fundamental information concerning the use of these isotopes in the dating of sedimentary rocks, the API Advisory Cttee on Fundamental Research on Occurrence and Recovery of Petroleum established API Research Project 53 in 1955. The research under this project, which is being conducted at the California Institute of Technology, is concerned primarily with the use of the isotopes of uranium and thorium, all of which decay to isotopes of lead. Two of the initial studies have been concerned with the distribution of these various isotopes in the oceans of the world and their beach sands. Another study has involved the distribution of these isotopes in limestones which have been intruded by an igneous body. The basic characteristic of all of this research is the manner in which both the radioactive and the sedimentary processes have been studied in order to provide better dating methods for the sedimentary process. (Author's abstract.)

DRILLING

120. Active search continues to improve drilling techniques. Anon. *World Petrol.*, 1958, **29** (9), 54.—Recent developments in the search for improved drilling methods include a variant of the turbo-drill known as the "wheel" drill. This consists of a diamond-faced cutting wheel powered by the turbine, which in turn is operated by the drilling fluid, but results of tests have not been published. The hammer-drill method, which has been extensively tested, is now said to be semi-commercial, but a new modified design is also being tested. The sonic drill, with vibrations of 60–90 cycles/sec operated by a mud turbine, is also still under development.

The uses, limitations, and advantages of turbo-drills are discussed, a main feature being the much greater h.p. delivered to the bit compared with the rotary method. Transmission losses can also be further reduced by increasing drill pipe dia. The main problem appears to be bit performance, since conventional bits are not designed for the high speed and power of the turbo-drills.

Other drilling techniques have improved penetration rates and reduced circulation losses in recent years; these include air or gas drilling, with the use of foaming agents and plastic grouting agents in wet wells.

For repairing holes in casing a tool has been devised which applies a plastic "patch" against the faulty section. This can seal the casing without seriously reducing its inside dia. C. A. F.

121. Air and gas drilling in the McAlester basin area. J. H. Adams. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 53–6.—Rotary drilling, with air or gas as a circulating medium, has been highly successful in drilling four wells in the extremely hard-rock area of E. Oklahoma and NW. Arkansas. An overall saving of 22% was realized by utilizing air or gas rather than using conventional rotary mud. One application of the exhaust-gas drilling technique was not so successful from an economic standpoint. When comparing this new drilling technique with mud-drilled wells, the average penetration rate was increased by 184% and the average footage per bit was increased by 630%. Optimum rotary speeds of from 40 to 60 rev/min provided a bit life of from 300 to 350 ton-hours while drilling through the hard Atoka shale. Air velocities below 2000 ft/min were insufficient to remove cuttings at depths below 4700 ft. This drilling technique has definite limitations and disadvantages. Formation water continues to be the principal obstacle to be overcome. Drilling with air or gas is still in the very early stages of development. Improvements in equipment and drilling techniques should result in even greater advancements in the performance and application of this relatively new drilling technique. (Author's abstract.)

122. Air and gas drilling as cost-cutters. J. F. Earl. *World Oil*, 1958, **147** (4), 83.—Air and gas drilling have proved successful in Terrell County, Texas, in combating hole deviation, slow penetration rates, and lost circulation. Results have shown that: (1) air and gas are superior to mud where formation water is not excessive; (2) the bottom hole assembly must be properly designed and rigid to combat hole deviation; (3) small amounts of water do not appear to impede the use of air or gas; (4) penetration rates can be increased up to six times faster than with mud; and (5) bit life can be increased by 300–400%. Case histories of air and gas drilled wells are given and tables show comparative results. C. A. F.

123. Instrumentation for the driller. J. W. Knowlton. *World Petrol.*, 1958, **29** (9), 66.—Drilling control instruments are an integral part of the rig, and a complete set of equipment consists of: (1) a weight indicator; (2) torque gauges; (3) electric tachometer for rotary speed; (4) pump pressure gauge; and (5) pump stroke-and-vol indicator. Each of these is briefly described, the need for recording various drilling functions being emphasized. A series of electric recording instruments has been introduced which supplement hydraulic recording equipment for bit weight, pump pressure, and torque. The new devices also record rate of penetration, and rotary and pump speeds. C. A. F.

124. Effect of low-frequency percussion in drilling hard rock. E. Topanelian. *J. Petrol. Tech.*, July 1958, **10** (7), 55–7.—In developing a fluid-operated hammer drill for accelerated penetration of hard rock, tests were made on granite blocks in the lab, and there were also field tests. Tubular hammers of various weights were used, as well as different drops, and frequencies up to 1020 blows/min.

On the basis of the ratio of penetration rates for percussion and conventional drilling, lab and field results agreed satisfactorily. Percussion superimposed on conventional drilling more than doubled the penetration rate for the normal static weight on the bit. Percussion could give the same penetration rate as drill collars commonly used in conventional drilling. In field tests percussion tools gave more than twice the penetration rates of conventional drilling at corresponding rotary speeds and weight on the bit. G. D. H.

125. Slim-hole drilling and completion practices, Cynthia area, Pembina field, Alberta. W. D. Freeborn and D. R. Wright. *Canad. Min. metall. Bull.*, 1958, **51** (557), 590–4.—Slim-hole drilling and completion techniques were first used in the Cynthia area of the Pembina field, Alberta, by the Texaco Exploration Company in the summer of 1957. Prior to that time, eighty-eight wells had been drilled and completed in this area in a conventional manner. Subsequent to the initial four-well evaluation programme, twenty-one additional wells have been drilled using slim-hole techniques. No difficulty was encountered in the drilling and completion of slim-hole wells, or in obtaining production from them.

A comparison of drilling and completion economics and practices has been made for slim-hole and conventionally completed wells. Penetration rates for both bit sizes (6¼ in. and 9 in.) were relatively equal. The shorter life of the smaller bits required the use of 15% more bits per well, but the total trip time to change bits was similar for both hole sizes because of the higher hoisting speeds possible with the

lighter drilling strings used in the slim holes and better hole conditions.

Completion costs of the slim holes were reduced by 37% as compared to the costs of conventional-type completions. This was made possible through the use of smaller well equipment, the elimination of tubing, and a reduction in rig time for completion operations. (Authors' abstract.)

126. Slim-hole drilling and 2½-inch casing, tubingless completions. J. H. Nicholls. *Canad. Min. metall. Bull.*, 1958, **51** (557), 585–9.—In this paper, Imperial Oil Ltd reports briefly on the drilling by contract rigs of twenty-nine slim holes in the Virden, Smiley, and Souris Valley areas. The investigations showed that slim-hole penetration rates, as a result of careful control of drilling variables, can approach those achieved with 7⅞-inch bits. It is concluded that slim-hole drilling is acceptable for development or exploratory work.

Imperial also reports on the completion techniques and equipment that have been developed on twenty-seven tubingless 2½-inch casing completions. Indications are that the method is economically desirable where excessive gas or water production is not anticipated. (Author's abstract.)

127. The application of flow properties to drilling mud problems. J. Mesaros. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 83–94.—Field engineers have seldom used the flow properties of drilling muds to overcome drilling problems because: (1) they are not familiar with fundamental flow-property concepts as expressed in field terms; (2) they hesitate to use the long, complicated flow-property equations; and (3) the multiple-speed viscometer needed to determine the necessary flow constants has not been available to them.

All of these objections are shown to be of minor importance when compared with the benefits to be gained. A proper use of drilling-mud flow properties makes control of the mud more certain and increases penetration rate. It aids greatly in solving such problems as pump liner selection, hole fill-up, gas cutting, and loss of circulation. (Author's abstract.)

128. A non-fermentable starch for drilling fluids. W. L. Owen and W. A. Romans. *World Petrol.*, 1958, **29** (9), 49.—Starch is one of the oldest colloidal materials to be used in muds for maintaining a satisfactory consistency and retarding water loss, and it has proved to be flexible, economical, safe, and relatively easy to use. It can, however, deteriorate rapidly in fresh water by the action of micro-organisms, so that it is limited to conditions where the pH of the fluid is above the range of microbe activity, or where the fluid is immunized by the use of preservatives. Several different preservatives have been used, and these are often expensive. Tests carried out with *ortho*benzyl *para*chlorphenol as a preservative gave favourable results; when reacted with the starch to give a 5% addition there was no deterioration within two weeks incubation, and it is thought that protection is afforded by firm adsorption of the agent on the surface of the starch grains. It is claimed that the treated starch is convenient and economical and should therefore soon be in use in the industry. Details of the testing procedures are given. 7 refs. C. A. F.

129. Profitability of capital expenditure for development drilling and producing property appraisal. J. J. Arps. *J. Petrol. Tech.*, July 1958, **10** (7), 13–20.—Several methods have been used for measuring the earning power of invested capital. The discounted cash flow method involves the idea of buying a series of future annual incomes; the accounting method considers the ratio of the average of the net annual profits and the average book investment over the life of the proposition, note being taken of the amortization pattern. The average annual rate of return method computes the ratio of the present value of the future earnings after amortization and the present value of the undepreciated balances of the investment over the life of the project. It reduces the computational work, removing trial-and-error solutions, and for oil industry investments subject to amortization on the unit-of-production basis gives more accurate results. The derivation of the formulæ is given, together with a series of charts which help in using the method, and some applications.

G. D. H.

PRODUCTION

130. Gas well hydrate control by subsurface injection of glycol. B. L. Moreau. *Canad. Min. metall. Bull.*, 1958, **51** (558), 638–42.—Certain gas wells tend to form hydrates in the production tubing. This paper outlines a method developed and used by the author's company to overcome the problem.

The injection of glycol to control hydrates results in sufficient dehydration to allow the gas to be transported through a field-gathering system to a treatment plant. Subsurface injection of glycol also offers a method of introducing corrosion inhibitors into the gas stream.

The major operating difficulties have been overcome, and the system is now in use in the northeastern part of British Columbia. (Author's abstract.)

131. The effect of fracturing on ultimate recovery in Mid-Continent sands. J. B. Campbell. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 57–60.—Experience in the Mid-Continent area shows that where applicable and judiciously applied, hydraulic fracturing increases ultimate oil recovery. The study is based on reconditioning treatments of wells in semi-depleted reservoirs, where production increases can be accurately evaluated from production decline curves, and examples are given. Although there has been a trend towards larger treatments, experience in the Keokuk pool, Oklahoma, indicates a definite limit to the recovery advantages to be gained by continuing to increase the size of treatment.

(Author's abstract.)

132. Reduction of failures caused by corrosion in pumping wells. T. A. Bertness. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 129–35.—This paper presents a discussion of the factors which should be considered for effective treatment of damage caused by scale and corrosion in California pumping wells.

Chemical inhibitors are of value in protecting subsurface equipment only to the extent that they can be placed where they are needed in the quantity and frequency required to do their job. Problems associated with the placement of inhibitors for protection of equipment from an environment of scale and corrosion in pumping wells are discussed.

The effect of loads on the life of rods is discussed, and histories of test equipment and well-treating methods are presented. It is concluded that the useful life of rods, pumps, and tubing in corrosive service is related not only to the corrosion protection supplied but also the nature and extent of the loads carried by the equipment. Data are presented which show that carbon rods provide equal or better service than alloy rods under the corrosive conditions tested. (Author's abstract.)

133. Progress in the development of sucker rods for oil well pumping. Pt 1. L. C. Uren. *World Petrol.*, 1958, **29** (9), 46.—The historical development of sucker rods for oil well pumps is outlined and the modern designs are described. Standards for rod joints have been prescribed, but materials for the rods have not been standardized and most manufacturers offer up to five grades of steel for use in particular well conditions. The carbon content of the steel varies from 0·08 to 0·43%, and manganese and other alloying agents are also used for special purposes, especially for increasing

strength. The most important properties of the steel are its tensile strength and yield point, the former ranging from 80,000 to 135,000 p.s.i. and the latter from 60,000 to 115,000 p.s.i.

Manufacturing techniques are briefly described, together with the problems of sucker rod failures in service. The latter include parting of rod joints due to unscrewing, wear, defective materials or workmanship, and overstressing.

C. A. F.

134. Note on buckling of tubing in pumping wells. T. Seldenrath and A. W. Wright. *J. Petrol. Tech.*, Aug. 1958, **10** (8), 49–51.—The buckling of tubing in a pumping well may be simulated to a tube fitted with frictionless pistons linked by an inelastic rod, and subjected to an internal pressure. The stress distribution is different from the loaded column to which the system has been compared. Mathematical investigation indicates that for the loaded column the compression forces are axial, with the moment at any section linearly related to the deflection; the pressurized tube has forces acting normal to the elastic line, with moments being almost independent of deflection. The critical hydrostatic force on the pistons approximates to or equals the buckling end load. Internally upset tube ends increase the critical internal pressure. G. D. H.

135. Application of statistics to the analysis of production decline data. A. T. Chatas and W. W. Yankie. *J. Petrol. Tech.*, Aug. 1958, **10** (8), 52–4.—The analysis of production data is often the basis for estimating the remaining reserves of a property. However, there may be problems in obtaining the best relationships between producing rate and time or cumulative production. The method of least squares can be applied to select the best numerical parameters to be included in the basic equations.

The mathematical procedure for applying the technique is outlined for the cases of hyperbolic and harmonic decline.

G. D. H.

136. Linear programming model for scheduling crude oil production. A. S. Lee and J. S. Aronofsky. *J. Petrol. Tech.*, July 1958, **10** (7), 51–4.—The models considered involve four ideal reservoirs and an unlimited outside source of oil, the aim being to schedule oil production over a period of eight years to obtain the max profit. The assumed profit/brl of oil from each source during each of four two-year periods has been estimated. Porosity, permeability, outer radius, and initial pressure are assumed for each reservoir, as well as an infinite water drive. There is a minimum reservoir pressure, and a limited pipeline capacity.

Illustrative results for the method are presented for a single-well system, and also for the case where one reservoir has two wells.

The model's limitations include the long time units used and the small number of wells; commonly, there would be no linear relationship between well pressure and rates.

G. D. H.

137. South Coles Levee unit cycling project, South Coles Levee field, Kern County, California. W. C. Sheldon and J. H. Sutton. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 141–51.—The South Coles Levee field contains three recognized reservoirs. The largest reservoir contains a retrograde system which has been recycled for over eleven years. This paper discusses the cycling project and the reservoir affected. The problems which occur in cycling a deep, high-pressure reservoir of considerable thickness are presented. The physical properties of the hydrocarbon system are included. The cycled interval has yielded 15·6 million brl of liq products, while *ca* half a pore vol of dry gas has been re-injected.

The success of this cycling project reflects the efforts to present an engineering approach to the many problems which have been encountered. A number of the engineering studies which have been made for this project are discussed. The results of studies have been widely used in planning the operation of this project and interpreting the results.

(Authors' abstract.)

138. Oil recovery by heat from *in situ* combustion. J. N. Breston. *J. Petrol. Tech.*, Aug. 1958, **10** (8), 13–17.—*In situ* combustion consumes relatively little oil (5–15%) and hot gases force oil and water to producing wells, the oil being almost unaltered. Steady combustion advance, the large heat wave, and halted combustion have all been used. 400–500 brl of oil/acre-ft may be needed for economic operation. Sweep efficiencies of 90% have been obtained in lab tests, but the practical limit may be 65%.

Pre-injection of air may be needed to give a sufficient air flow for combustion. Ignition has been electrical, by gas burners, or super-heated air. For continuous burning 4–10 cu. ft. of air/hr/sq. ft. may be needed. There are indications that *ca* 340 cu. ft. of air may be needed to sweep 1 cu. ft. of reservoir. 10,000–28,000 cu. ft. of air/brl of oil may be used in stabilized combustion. The true fuel is residual carbon left by cracking and dist of the oil. Resuming air injection may re-establish combustion after several weeks shut-down.

Compression costs may be $0·5–1·5/brl of oil recovered, and these may be the main costs. Field operations may call for 1–2 h.p. compressor capacity/acre-ft of reservoir.

G. D. H.

139. Proper pumping speeds for deep wells. T. H. Fraser. *World Oil*, 1958, **147** (4), 89.—A method for determining the proper pumping speeds for deep wells with three- and four-way tapered rod strings is presented. The procedure consists of six steps, the appropriate formula and method of calc for each being given. The result gives the max number of strokes/min. It is important that a non-synchronous pumping speed is selected, in which case dynamic stretch due to fluid load can be ignored. An example of the use of the method is given. C. A. F.

140. New trends in chemical control of paraffin. B. Cranford. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 61–7.—The basic methods of handling paraffin problems in oil production are mechanical, thermal, and chemical. This paper is concerned only with the control of paraffin through use of chemicals.

Producing and transporting problems created by the deposition of " paraffin " in the system exist in the majority of the world's oilfields. The particular problems created by the paraffin deposit or its degree of severity will vary and will be common to certain areas of similar conditions. As a result of this characteristic of the problem, it is necessary that the treating programmes be flexible and be adapted to the particular condition. Before such a programme is designed, a complete survey of the problem should be made.

(Author's abstract.)

141. Reliable interpretation of water flood production data. J. K. Jordan. *J. Petrol. Tech.*, Aug. 1958, **10** (8), 18–24.—The full use of reservoir analysis is the best guide to the performance of secondary recovery by water flood. Even though full field data may not be available, some quantitative interpretation is generally possible. Sweep efficiency and oil recovery at any stage of depletion may be obtainable from water injection and oil and water production data, the time and place of water breakthrough, and individual well behaviour. Curves relating oil production and time have severe limitations from the point of view of predicting future recovery, but plots of cumulative oil and cumulative water and oil produced against cumulative water injected indicate the efficiency of the operation, pointing to fill-up, and whether water is going outside the area of special interest.

The reservoir properties of interest are described and several field examples are discussed. G. D. H.

142. Automatic custody transfer operation. S. H. Pope. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 95–104.—The principle of lease automatic custody transfer (LACT) became of age in 1956. At least 1½ million brl of crude, valued at approx $4 million, were handled during the year in the U.S.A. and Canada in a manner acceptable to both producer and transporter. Some eight systems incorporating either measurement by tank or measurement by positive displacement meter were in operation by the end of 1956 in five different states and provinces. Two systems operated during the entire year. A review of the operating experience in automatic, unattended operation indicates that the requirements for accurate determination of quantity and quality of the crude have been met. Operation has been relatively trouble-free. The max benefits of automation will be derived from general use. With a limited number of systems, proved advantages to date include reduction in initial cost at producing rates in excess of 500 b.d., elimination of B.S. & W. accumulations, and decreased time required in the preparation of run tickets.

Acceptance of the principle of LACT heralds the dawn of a new era in crude oil handling from well to refinery. Complete automation of producing and transporting facilities is now within reach. It is up to industry to take full advantage of this new method. The great strides made in LACT in a relatively short period of time are indeed a tribute to the organization of the API, which co-ordinated the activities of the various companies through the Cttee on Crude Oil Measurements, Special Project Group, Lease Automatic Custody Transfer. (Author's abstract.)

143. Reservoir wettability—its significance and evaluation. J. E. Bobek, C. C. Mattax, and M. O. Denekas. *J. Petrol. Tech.*, July 1958, **10** (7), AIMME Tech. Paper No. 8021, 155–60.—Rock wettability markedly affects the displacement of oil by water from oil-producing horizons. Core tests often show greater oil recoveries by water drive or water flood when the rock is water-wet rather than oil-wet.

Lab and field studies on rock wettability were made. The rate and vol of spontaneous inhibition of the wetting phase were found to give reliable and reproducible data on rock wettability. In lab tests wettability was found to depend on the rock type and the crude oil. Coring fluids and handling techniques were found to have significant effects on rocks; oil-base muds can change water-wet rocks to neutral or oil-wet. Brines and some water-base muds seem best for avoiding wettability changes. Weathering should be avoided, and preservation of cores in oxygen-free brine in sealed containers is recommended.

Wettability tests on six reservoirs showed them to be water-wet, although to different extents. G. D. H.

144. How predicted and actual performance compared in a West Texas reservoir. E. E. Runyan. *World Oil*, 1958, **147** (4), 97.—Comparison of the predicted with the actual reservoir performance for the Williams field, Coleman County, Texas, has shown that the predicted ultimate oil recovery agrees well with the actual ultimate oil recovery, the actual gas–oil ratio being lower and the actual reservoir pressure slightly higher than predicted. Performance was calc using the Tarner method of material balance, with PVT data obtained from an initial sample. The field is a stratigraphic trap, with no evidence of faulting, and pay is Pennsylvanian Gray sand at *ca* 3750 ft. There has been no significant water production, but there is a large gas cap. Comparison was for a 10-year period up to Jan. 1957. Predicted oil recovery was 35·6% of initial oil in place (approx 1,710,000 brl), with a depletion pressure of 200 p.s.i. Actual production to Jan. 1957 was 32·77% of initial oil in place and decline curve extrapolation indicates an ultimate recovery of 36·4%. Charts show the comparison between actual and predicted performance. C. A. F.

145. Density logging in the Gulf Coast area. J. L. P. Campbell and J. C. Wilson. *J. Petrol. Tech.*, July 1958, **10** (7), 21–5.—Density logging depends on the absorption and scattering of γ-rays derived from a cobalt-60 source held in contact with the well wall to minimize borehole effects. The γ-ray intensity recorded is a measure of the density of the rocks, and the size of the sample investigated averages *ca* 1 cu. ft. Comparison with measurements on cores suggests an accuracy for the logging of *ca* 0·03 g/cc. If the grain density is known, or assumed, porosities can be estimated from the log data, and can be more reliable than core measurements, especially if the borehole dia is fairly constant.

Density logs may also be used in correlation and lithological studies, but local field knowledge is needed to interpret the results in terms of gas or liq filled porosity. G. D. H.

146. Porosity balance verifies water saturation determined from logs. M. P. Tixier. *J. Petrol. Tech.*, July 1958, **10** (7), AIMME Tech. Paper No. 8022, 161–9.—Saturation values can be derived from logs by several resistivity ratio methods: induction–electrical log method, Rocky Mountain method, or R_{xo}/R_t method. These yield values of the formation factor via the appropriate relationships, and this value, in the porosity balance technique, is compared with the formation factor obtained independently. If the calculated value is too low the corresponding saturation is also low; if the value is too high, the saturation is high in general. This check can prevent large errors and often improves interpretation.

The use of the porosity balance technique is discussed for each of the interpretive methods and for shaly sands. G. D. H.

147. Gas injectivity profile logging is successful. R. H. Widmyer. *World Oil*, 1958, **147** (4), 117.—The position of gas entry into a formation can be located by using a radioactive tracer to identify one of two injection streams entering the well. One of the streams enters via the tubing and the other through the annulus. The two streams will meet at a level which can be detected by running a γ-ray log over the zone of interest and so the level at which gas is entering the formation can be determined by adjusting the injection rates. The rates of the two streams are controlled by valves at the surface, and it has been found that the best results are obtained if the combined rates of the streams are held at the normal injection rate for the well. Examples of injectivity profiles are given and the advantages of the technique listed. It is particularly useful because it can be used either in cased or open holes, tubing need not be pulled, and no elaborate preparation of the well is required. C. A. F.

148. Petroleum in Austria. (In French.) R. Belfond. *Rev. Petrolière*, Dec. 1956, (986), 31–4.—Since 1930, when the first petroleum deposit was discovered near Zistersdorf at 729 m depth, production has risen from 5 tons to 1,213,515 tons in 1944. During the Suez crisis attention turned to Austria—a small consumer—with *ca* 1,500,000 tons of exportable petroleum. On Austrian liberation, 15 May 1955, Russia imposed on her the delivery of 1 million tons p.a. free for 10 years, and a further 200,000 tons for 6 years, as redemption for Nazi property in Austria restored at the end of the occupation. Russia influenced Austrian petroleum economy, but the indemnities for investments and efforts are iniquitous. Russians discovered and put into operation the largest petroliferous basin in W. Europe, Matzen-Auersthal, with production threefold that of Parentis, the second largest in W. Europe. After the Hungarian debacle, the petroleum industry—the stronghold of Communism—lost many communists. Traces of Russian occupation are being obliterated.

Prosperity of the country depends on rational, intensive exploitation of petroleum resources. Considerable investments are required to modernize refineries and extend the pipeline network. Since admission to the Council of Europe Austria has become important as the only country in Europe able to supply petroleum to its neighbours. R. T.

OILFIELD DEVELOPMENT

149. U.S. can long supply growing gas demand. R. L. Miller. *World Oil*, 1958, **147** (4), 136.—A large increase in natural gas consumption in the U.S.A. is expected during the next few decades. At present consumption is 10 trillion cu. ft/year and this is expected to reach 19 trillion cu. ft. by 1975. The peak will probably be reached, because of limited supplies, in 40–50 years, and although domestic reserves should meet demand for many years, it will be possible to augment supplies by pipeline from Canada and Mexico, and shipment in liquefied form from the Middle East and elsewhere may become feasible. Considerations in the estimating of proved and ultimate gas reserves are noted and some recent estimates discussed. Charts show: (1) marketed and proved reserves of natural gas in the U.S.A., 1918–56, and (2) natural gas production, 1918–56. C. A. F.

150. Shallow production spurs Delaware basin activity. Anon. *World Oil*, 1958, **147** (4), 94.—There is active exploration and development in the Delaware basin, W. Texas, and the area is expected to reach its peak development in the near future. This is due to the recent discovery of good production from shallow Delaware sand fields; increased interest in deep possibilities in the basin; higher initial production due to fracturing, which has increased the output from the shallow fields; and relatively easy drilling. Both rotary and cable tool rigs are used, and air- and water-base drilling media have been employed.

There are few major structural features in the basin, and the pay sands are long and fairly narrow. Delaware sand fields are essentially stratigraphic traps, and usual geological and geophysical methods are of little value. Most useful methods involve following shows, subsurface geology, and infill drilling between producing areas. An outline of a typical completion programme is given. C. A. F.

151. More orderly procedure marks offshore drilling. J. W. Calvert. *World Petrol.*, 1958, **29** (9), 36.—*Ca* 60 rigs are now operating offshore from Texas and Louisiana, compared to the peak period of 1957 when *ca* 160 rigs were in use. None of the fields discovered has yet been completely developed, and the potential of the offshore area cannot be estimated accurately. To date proved offshore reserves are 800 million brl and 5 trillion cu. ft. gas, but the national economic decline has affected this area, and it appears that the intensive and highly costly period of offshore development is over. Economy in drilling and development is being emphasized, and there has been a reduction in wildcatting with more concentration on development drilling. C. A. F.

152. Deep gas pay active in Pennsylvania, W. Virginia. Anon. *World Oil*, 1958, **147** (4), 113.—Air and gas drilling methods have largely replaced cable tools in W. Pennsylvania and NE. West Virginia, where hard rocks are encountered. In this area there are big surface structures which have been known for many years, and gas occurs in the Onondaga chert and Oriskany sandstone, along a trend extending over 200 miles. Rapid development of these fields was not possible until improved drilling methods enabled routine drilling to be carried to 8000 ft and below. Productivity has been increased by the use of hydraulic fracturing.

Reservoir conditions in the pays are generally unpredictable, permeability and porosity being very irregular. The biggest field on the trend is Driftwood–Benezette, covering *ca* 43,000 acres, where *ca* 300 producing wells have been completed. Gas in the area fetches a good price because of proximity to E. markets. C. A. F.

153. Brightest hope for the newest state. T. C. McClary. *API Quart.*, Summer 1958, 18–23.—7 July 1958 brought statehood to Alaska, the 49th state. Statehood is the political, oil the economic news. Alaska lies in one of the world's four great intercontinental depressions favourable to petroleum recovery. Reviewing global oil resources in 1944, W. Pratt classified the territory with the Near and Middle East, the islands of the Far East, and the basin between N. and S. America. The fourth intercontinental depression surrounds the N. Pole, is occupied by the Arctic Sea, and lies between N. America, Europe, and Asia. Current extensive leasing followed Richfield Oil Corpn's discovery Swanson River 1, on the Kenai Peninsula *ca* 40 miles SW. of Anchorage. Initial flow rate of >200 b.d. increased by 29 Sept., on completion, to 900 b.d. of 33° API oil. Difficult terrain and climatic conditions will make outlay costly. Outstanding areas of interest, in addition to land adjoining the Naval Reserve—some of which is being released—are the Kenai Peninsula on the E. side of Cook Inlet, the Katalla–Yakatage region at the head of the Gulf of Alaska, the Alaska Peninsula, and Koyukuk basin W. of Fairbanks. Almost equally rated are Cooper River basin and Kuskokwim and Porcupine–Kandik areas. Provision of market outlets for oil may prove difficult. R. T.

154. Offshore seismic exploration in the Caribbean area. Anon. *World Petrol.*, 1958, **29** (9), 56.—There has been extensive geophysical activity in the Caribbean area during the last two years, and one of the most promising regions is the Gulf of Paria between Trinidad and Venezuela. This covers some 3200 sq. miles, and oil has been found offshore from Trinidad. There should also be excellent opportunities on the shelf in the Gulf of Venezuela N. of Lake Maracaibo, and other shelf areas have possibilities.

Offshore survey problems in the area are outlined, together with problems of recording and interpreting data. In places, the presence of rough coral bottoms limits the use of bottom cables and complicates seismic interpretation by introducing strong reflected signals from the sea floor. C. A. F.

155. Brazil's oil potential—an economic and geologic evaluation. J. O. Nigra. *World Petrol.*, 1958, **29** (6), 38.—Oil output in Brazil has trebled in one year, but production has reached only *ca* 35,000 b.d. Exploration is difficult and expensive because of heavy jungle cover, thick alluvium, and lava blankets. There are extensive sedimentary basins which flank the Brazilian shield. These are the NW.–SE. Andean seaway, the E.–W. Amazon trough, the NE.–SW. Maranhao–Parnaiba embayment, the NE. Coastal province, and the NE.–SW. Parana basin. These are relatively shallow, and the largest, the Amazon trough, contains mainly non-marine beds which are probably barren. Potentially productive Cretaceous and Tertiary rocks are sparse, and the only extensive marine beds are in the Lower Palæozoic. Areas apparently structurally favourable have been found in places to have been intruded by diabase sheets.

Oil development is also hindered by a shortage of geologists, poor communications, and lack of adequate maps. 18 refs. C. A. F.

TRANSPORT AND STORAGE

156. Use of thin-wall pipe in natural gas pipelines. R. S. Ryan. *Oil Gas J.*, 25.8.58, **56** (34), 68.—Thin-walled piping can be used in construction without difficulty provided care is taken in handling. Bending characteristics are difficult to predict—thin-wall pipe can be welded.

A table shows comparative costs for thin-wall and conventional pipe and gives saving per mile.

G. A. C.

157. First major oil pipeline is being built in West Germany. R. S. Cannon. *Pipe Line News*, 1958, **30** (10), 34–9.—A German corporation, Nordwest Oelleitung, is currently building Germany's first large-scale crude oil pipeline—28 inch dia with a final capacity up to 500,000 b.d. The line starts at Wilhelmshaven on the North Sea and extends to Wesseling near Cologne and will serve six refineries in the Ruhr area. Total length of the pipeline will be approx 230 miles. A number of grades of crude will be handled varying from 0·823 to 0·903 sp. gr. Remote operation of the delivery facilities will be sequenced so that the operator at Wilhelmshaven will only push one button to initiate a delivery to any given refinery. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

158. Materials of construction. E. H. Edwards. *Oil Gas J.*, 20.10.58, **56** (42), 82.—Trends, developments, and problems in materials application in the petrochemical industry are considered. Limitations of present materials affect rate of technological advances regarding new products. Tantalum, molybdenum, and zirconium are metals which are attractive because of their resistance to attack by mineral acids at high temp; and where equipment can be made from them it can be used at temp several hundred degrees (F) higher than max at present feasible with next-best alloy. G. A. C.

159. The design of smokeless non-luminous flares. P. D. Miller, H. J. Hibshman, and J. R. Connell. *Petrol. Times*, 12.9.58, **62** (1954), 764.—Extracts from an API paper by the above include development, open air and confined tests, commercial operation, and costs.

Clean burning of gas follows its mixing with sufficient air at a fast enough rate to minimize carbon formation and to burn carbon formed before it can agglomerate and form soot. Experiments established that shorter and less smoky flames resulted as jets were reduced in size, and 15 inches was found to be optimum jet spacing.

Installation of horizontal pipes across burner *ca* one inch above ports gave satisfactory flameholding and initial propagation of flame from one jet to another. Silicon carbide flame holders proved best.

Design criteria for sizing equipment, stack dimensions, burner stages, number of jets, and flameholder given, together with critical dimensions. G. A. C.

160. Computers, gasoline plants, and ivory towers. R. L. McIntire. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 65–9.—This paper deals with the variety of ways in which gasoline plant designers can use the modern electronic computer. The computer is now helping to locate plants, plan the internal fractional separations, specify the vessels, flanges, pipes, and even design the retaining walls. All of these applications are familiar time-consumers to the design engineer.

Most important, however, is the work of the designer, which determines the plant's productive capabilities. This paper develops the preliminary analysis of a single machine procedure by which material balances on any gasoline plant may be obtained. The computer would be controlled by a simple data sheet which specifies the flow of all feed, product, and recycle streams within the plant.

Seven major incentives for using electronic computers are cited: shorter time, increased coverage, research, unexpected results, competitive costs, competitive position, and engineer acceptance. Unexpected results are frequently the greatest reason for payout of a computer application.

(Author's abstract.)

161. Economy starts with design. N. C. Turner. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 78–81.—The shrinking profitability of projected gasoline plants necessitates reduction in the initial cost of the plant wherever possible. The author suggests that taking a critical look at some time-honoured equipment specifications might result in substantial savings in the initial cost of the plant. Recommendations as to the method of setting up the basis for plant design are given. The most economical type of contract and methods of selecting engineering contractors are also discussed.

(Author's abstract.)

162. Reduction of operating costs and increased recovery through plant modification. V. E. Middlebrook. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 82–4.—Rewarding results as increased profits can be expected through reduction in operating costs by giving careful attention in modification and expansion programmes to the many process and mechanical design features which influence plant overall thermal efficiency. Proper rating and selection of mechanical equipment pays substantial dividends, especially as plants grow older and are faced with diminishing returns. Max use of automatic controls eliminates the human element of error, reduces labour, and increases net operating income. High product recoveries are essentially related to the degree of success attained in selectively eliminating the methane and ethane unavoidably absorbed or liquefied in primary extraction processes. (Author's abstract.)

163. Modernization of Imperial Oil refinery at Halifax. C. M. Stewart. *Engng J., Montreal*, 1958, **41** (7), 70–6.—On 11 Oct. 1956 the completely modernized 42,000-b.d. Halifax refinery of Imperial Oil Ltd, costing approx $30,000,000, was opened officially. New process facilities—raw material and product flow shown in a schematic diagram—consist of seven main units designed to process Venezuelan or Middle East crude, all crude being brought to the refinery by tanker. The first unit, a 45,000-b.s.d. atm and vac unit, splits crude into gasoline constituents, fuel oil products, and fractions for further processing. A 15,000-b.s.d. cat cracker with a preheating furnace breaks heavier hydrocarbons into lighter, higher octane fractions. Gases, gasoline stocks, heating oil, and bunker flux are produced. A light ends recovery unit recovers potential gasoline stocks from the atm and vac unit, the cat cracker, and Powerformer. This unit produces also feed stock, butylenes, and propylenes for the 5000-b.s.d. cat poly unit. Polymerization at high temp on phosphoric acid cat produces high-O.N. liq polymer. An 800-b.s.d. LPG plant

processes gases from the cat poly plant to produce propane. A 7000-b.s.d. Powerformer produces high-O.N. gasolines using a Pt cat and desulphurized low-O.N. natural naphthas. Process equipment incorporates elec coalescers using a potential field of 45,000 V d.c. to separate emulsions in the treating plants. Alloy steels are used to combat corrosion from high-temp S and H_2 attack. Channel surfaces of all coolers are neoprene lined and Al-brass tubes and tube sheets are used. New docks have been constructed to take the largest supertankers afloat. Over 60 miles of piping and an extensive pumping system are installed for product handling. Crude may be unloaded at a rate of 20,000 brl/hr and products loaded at *ca* 7500 brl/hr. A colour scheme in 23 colours is described, and labour forces and welding are discussed. R. T.

CRACKING

164. The influence of steam on the high temperature cracking of gas oil. (In Russian.) V. S. Aliev *et al.* *Khim. i Tekhnol. Topliva i Masel.*, 1958, (8), 44–9.—Inert diluents in the process inhibited both secondary aromatization reactions and the formation of light hydrocarbons in the gaseous product. Steam acted not only as a diluent but also reacted chemically with the coke to produce CO and H. The free hydrogen inhibited the reactions leading to the formation of aromatic hydrocarbons and increased the yield of ethylene. G. W. T.

165. Research on plant for producing hydrogen by the catalytic conversion of gaseous hydrocarbons with steam. (In Russian.) N. B. Zhadanovskii. *Khim. i Tekhnol. Topliva i Masel.*, 1958, (8), 38–44.—Methods of reducing the cost of steam used in producing hydrogen by the cat conversion of gaseous hydrocarbons were considered. The most feasible methods are: (1) replacement of the three-stage conversion of CO and monoethanolamine refining of the gas, by removal of CO and CO_2 from the crude hydrogen by aq and cuprammonium refining; (2) changing to a single-stage $CO \rightarrow CO_2$ conversion instead of a three-stage one. The first method could only be applied to new plants under construction. G. W. T.

HYDROGENATION

166. Hydrogenating in the middle-range pressure refining of brown-coal-tar middle oils with a twin-chamber apparatus. (In German.) R. Birthler *et al.* *Chem. Tech., Berlin*, 1958, **10**, 75–8.—Description is given of a plant for hydrogenation of tar oils of high hetero-atom content and polymerizable constituents in which the conventional single four-chamber construction for the heat exchangers and cat-packed reaction towers is replaced by a double three-chamber arrangement with accompanying heat exchangers. Operating costs are decreased and capacity increased. The regeneration of MoO_2 cat is described. G. W. T.

POLYMERIZATION

167. Ethylene polymerization with soluble catalysts. (In Italian.) M. Farina and M. Ragazzini. *Chim. e Industr.*, 1958, **40** (10), 816–19.—The polymerization of ethylene to high linear polymers by means of cat soluble in hydrocarbons, obtained from cpds of transition metals and metallo-organic-cpds such as Ti tetra-alcoholates and Al trialkyls has been investigated.

From preceding studies it was noted that the cat systems thus formed polymerize ethylene mainly to butene (dimerization). The authors' investigation has shown that the type of reaction is strictly dependent on the experimental conditions; in particular the Al/Ti ratio and the method of cat preparation. It is possible, by choosing the proper experimental conditions, to go from a pure dimerization to a true polymerization to high mol. wt. products.

The study of the reaction under the more general conditions, *i.e.* when butene as well as polyethylene are obtained, has shown that the two processes are not simultaneous but occur for the major part in clearly distinct ways. (Authors' abstract.)

168. Copolymerization of ethylene with aliphatic α-olefins. V. Ethylene–propylene copolymerization by catalysts prepared from titanium alogenides. (In Italian.) G. Natta *et al.* *Chim. e Industr.*, 1958, **40** (11), 896–905.—Copolymerization of ethylene with propylene in the presence of cat prepared from Al trialkyls and different Tl chlorides is described.

The influence of different factors on the composition of copolymers is examined for each Ti alogenide, and the condition is established in which the product of the reaction (operating in the presence of Al trihexyl) consists of linear, amorphous copolymers of high mol. wt., free of homopolymers and of crystalline copolymers.

From the results of a series of experiments carried out with mixtures of monomers of different composition, the values assumed by the reactivity ratios of the two monomers in the copolymerization, in the presence of cat prepared from $TiCl_4$, $TiCl_3$ (α modification), and from crystalline $TiCl_2$ have been determined. (Authors' abstract.)

ALKYLATION

169. Products distribution in consecutive alkylations of aromatic hydrocarbons by propylene. (In Italian.) P. Beltrame. *Chim. e Industr.*, 1958, **40** (11), 906–8.—Alkylation of benzene and cumene by propylene was studied at different temp employing $AlCl_3$ as a cat. Products were separated by dist. Distribution constants for the consecutive reactions were obtained and an approx method allowed also the calculation of rate constants for the single steps.

It has been concluded that the consecutive reactions investigated are thoroughly independent from each other. (Author's abstract.)

ISOMERIZATION

170. These variables affect OXO reactions. I. Kirshenbaum and V. L. Hughes. *Petrol. Refin.*, 1958, **37** (6), 209–11.—In the OXO reaction, CO and H_2 are reacted with an olefin to produce aldehydes and alcohols. The type of product obtained depends upon operating conditions as well as the type of refinery olefin feedstock. The authors discuss all the process variables related to the OXO reaction, dealing with the different structural types of olefins used, and their reactivities, in detail. J. R. T.

CHEMICAL AND PHYSICAL REFINING

171. Treatment of waste acids from oil refineries. (In Czech.) J. Schneider. *Chem. Prom.*, 1958, **8**, 458–63.—This article presents an original method for converting corrosive tar-acids into a loose, non-corrosive, readily transportable mixture. Solid, semi-liq, or liq tar-acids, by-products of refining, are mixed with lean indigenous pyrite earth. This mixture contains 10–11% combustible sulphur and 4–5% combustible carbon, and can be roasted in fluidized bed furnaces without added heat. The combustible sulphur content of the residue is less than 1%. G. W. T.

SPECIAL PROCESSES

172. Application of Unisol process in Great Britain. C. H. Bond and A. Cluer. *Petroleum, Lond.*, 1958, **11** (9), 305–9.—In 1940 a 1000-b.d. U.O.P. thermal cracking unit was installed at Lobitos Co.'s refinery at Ellesmere Port to process low sulphur residues from Peruvian and Ecuadorian crude oils. In 1950 it became necessary to import sour Middle East crude and use it as feed to the pre-topping cracking plant. The mercaptan sulphur content of the cracked Kuwait gasoline was expected to be around 0·06–0·09% by wt, *i.e. ca* ten times as sour as anything previously handled. To remove the sulphur a 600-b.d. Unisol plant was put up, and it has been in operation since May 1953. This is the only Unisol plant in Great Britain.

A schematic description of the plant is given, and the results of the first four years' operation are discussed. The most noteworthy point in operation has been that extraction efficiency has been maintained in spite of wide changes in plant throughput and during periods when operating conditions were far from optimum. M. F. M.

173. Solidified petrol. Anon. *Petrol. Times*, 10.10.58, **62** (1596), 840.—The technique used in Russia to produce briquettes of solid fuel is described and consists essentially of making an emulsion of petrol, the petrol being in high concn, and the addition of a stabilizer to form a protective film and a plasticizer to solidify it. Petrol is recovered from the solid briquettes by pressing. G. A. C.

174. Oxidation of phenanthrene to diphenic acid with peracetic acid. (In German.) W. F. O'Connor, F. T. Wallenberger, and E. J. Morricon. *BrennstChemie*, 1957, **38** (11–12), 170–3.—By the process described—single-stage oxidn of phenanthrene to diphenic acid—the peracetic acid process oxidn appears to be the most favourable. Oxidn with 40% peracetic acid in an improved glass lab apparatus gives yields of 63–66% (88–93 g) of practically white diphenic acid m.p. 226°–228° C. Improvements in the process led to a working cost reduction of 2%. Esters of diphenic acid are used in plasticizer and alkyd resin production. Adaptation of the method using stainless steel apparatus gave successful working and yields of 66% (0·77 kg) diphenic acid m.p. 226°–228° C. R. T.

METERING AND CONTROL

175. A new way to measure product in slack lines. Anon. *Oil Gas J.*, 8.9.58, **56** (36), 88.—Air and product left in pipelines after bulk transfers from barges and tankers lead to inaccuracies in measurement. Quantity of air in a pipeline can be ascertained by noting increase of pressure in line after a known quantity of compressed air has been introduced.

A 4-inch large capacity gas meter is installed between a 10-h.p., 40-c.f.m. air compressor and the pipelines in which slack is to be measured; accuracy is within 10% of the slack quantity. Procedure is given, but system should not be used for lines in kerosine or jet fuel service owing to risk of static electricity build-up. G. A. C.

176. Electronic-controlled cat cracker. C. D. Gingrich. *Oil Gas J.*, 20.10.58, **56** (42), 77.—The Regent Refining (Canada) Ltd's plant at Port Credit, Ontario, processing 25,000 b.d. W. Canadian crude oil, includes a 7000-b.d. fluid cat cracking unit basically powered by electricity. An automatic restarting scheme is made possible by the electronic instrumentation; an automatic shutdown and steamout system is provided in case of air blower failure. Installation cost is more economical for electronic than for pneumatic control, and the system is superior. G. A. C.

PRODUCTS

CHEMISTRY AND PHYSICS

177. Hydrocarbon partial enthalpies and the convergence pressure K value charts. W. C. Edmister. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 4–11.—With the completion and publication of the NGAA K value charts, the question "What next?" is asked. The development of compatible partial enthalpy charts for the same hydrocarbons is suggested as a logical and worthwhile project for NGAA to sponsor. Thermodynamic equations and date sources for computing partial enthalpies are presented. Previous work on mixture enthalpies is reviewed and a procedure outlined for developing the proposed partial enthalpy charts. (Author's abstract.)

178. Fundamental research on the anti-knock properties of pure hydrocarbons and their blends. L. C. Beard, Jr. *Proc. Amer. Petrol. Inst.*, 1957, **37** (6), 35–45.—19 years of the work of API Research Project 45 are reviewed, with emphasis on the anti-knock ratings of blends. Simple examples are given of the effect of chemical structure on the anti-knock ratings of some C_7 hydrocarbons. The technical inadequacy of calculated blending O.N. is pointed out.

Recognition is given to the adverse influence of engine severity on the usefulness of anti-knock ratings of simple two-component blends—in understanding departures from linearity when two pure hydrocarbons of different O.N. are blended and knock-tested. By using two-component "matched blends," where each of the components is of the same hydrocarbon type and O.N., it is demonstrated that, divorced from engine severity, the departures from linearity are real and probably due to chemical interaction.

Data from work with matched blends show that most interactions are reflected in a synergistic departure from linearity. Interaction is prominent for blends of different hydrocarbon types. Synergism is favoured by TEL, the Research Method, high anti-knock levels, and paraffins as one blend component. Examples are also given of blends showing antagonism. (Author's abstract.)

179. Investigations on the influence of pressure and temperature on combustion rate of 2,2,4-trimethylpentane and 2,2,3-trimethylbutane–air mixtures. (In German.) E. Terres and K-J. Hoppe. *BrennstChemie*, 1957, **38** (11–12), 161–7.—From a résumé of former investigations it is concluded that the combustion rates of all knockproof hydrocarbons—in the available apparatus—do not exceed notably the order of magnitude of 25 m/sec. Further, in the current permissible C.R. all hydrocarbons attain these combustion rates of their stoichiometric mixtures with air. To support these conclusions combustion rates of two highly knock-resistant *iso*-paraffins, test-*iso*-octane and triptane in stoichiometric mixture with air—in dependence on initial pressure and temp—were determined. The results—confirming these conclusions—show that increasing initial pressures from a definite initial temp, at the combustion rate of combustible hydrocarbon–air mixtures rise up to a max val characteristic for the initial temp in question. Initial pressures of 12–14 atm correspond to the attainable combustion rate for test-*iso*-octane, coinciding approx with the crit C.R. in the motor. With triptane the max attainable combustion rates lie at somewhat higher original pressure, *ca* 18 atm. This agrees with the higher knock resistance of triptane, whose

crit C.R. is given as 14–16. These numerical max val of combustion rate are approx of the same order of magnitude for both hydrocarbons at all test temp and pressures. 11 refs. R. T.

180. Representation of NGAA Equilibrium Ratio Data for machine computations. R. L. Norman and B. Williams. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 61–4.—Values of "K" have been read from vapour–liq equilibrium charts in the Equilibrium Ratio Data Book of the NGAA. *Ca* 65,000 points have been read at intervals of temp and pressure chosen so that linear interpolation between points is possible with a negligible error. The tables of data cover the 12 paraffinic hydrocarbons, methane through decane for each of the nine convergence pressures. A method of reducing the data to equations suitable for computer using has been developed and is described. It is possible to represent each page in the data book by a polynomial which gives K as a function of temp and pressure over the usable range of each chart. Equations are given for the three convergence pressures of 2000, 5000, and 10,000 p.s.i.a., and the work is being continued. Simpler correlations are mentioned for use where data are not required over the full range of a chart. (Authors' abstract.)

181. Measurement of drop size of atomized fuel. P. G. Morgan. *Fluid Handl.*, 1958, 279–80.—Widely used method of catching drops on soot-covered surface and measuring dia of indentations is considered in detail. High speed photos (5×10^4 frames/sec) showing method of formation of indentations indicate importance of drop size and speed; Weber No. is insufficient to characterize the process. The method should be restricted to cases where all impressions are single and deep, with sharp edges. W. A. M.

182. Production of methane from carbon. J. D. Blackwood. *Nature, Lond.*, 1958, **182**, 1014.—For a given carbon the rate of formation of CH_4 at a given temp and pressure is approx the same ($1–2 \times 10^{-4}$ g mol/min/g carbon) whether steam or H_2O be employed. The rate varies with the temp at which the carbon was prepared. The formation of CH_4 under these conditions is thought to be controlled by O groups, such as chromene or benzpyran, in the carbon structure. H. C. E.

ANALYSIS AND TESTING

183. Using a radioactive liner for studying engine wear. P. J. Agius and R. E. Pegg. *Inst. Petrol. Rev.*, 1958, **12** (142), 337–40.—Radioactive tracers are applied to measure liner wear, the liner being irradiated at Harwell, fitted in an engine, and radioactive wear products in the crankcase oil measured by means of a γ-scintillation unit. Description of the special tools and techniques needed in order to keep at least 3 ft from the engine are described and also how a liner is fitted into a Foden FD-6 engine already installed in a tractor unit. Results are given of wear in a Standard Vanguard engine with different lub oils and fuels. 7 refs. E. M. I.

184. Controlled moisture condensation apparatus for evaluation of rust-preventive oils. H. Roden. *Bull. Amer. Soc. Test. Mat.*, 1957, (223), 53–61.—Limitations of present box-type humidity cabinets used in evaluation of rust preventives are indicated and details presented of a comparative investigation utilizing the standard humidity cabinet and procedure as stipulated in U.S. Army Spec. 2–126 and a closed cell high-humidity moisture condensation apparatus developed by the Texas Co. The latter is described and illustrated, and comparisons of results obtained with both types of apparatus over a wide range of conditions indicate a marked superiority of the closed cell equipment from the standpoints of reproducibility, speed of testing, and flexibility of operating conditions. Ratings obtained on this equipment show good correlation with those obtained on the humidity cabinet. J. G. H.

185. Electron diffraction in lubrication research. D. Godfrey. *Lubric. Engng*, 1957, **13** (11), 598.—The value of electron diffraction in providing information on the nature of the surface in lubrication studies is indicated and the basic theory of the technique is summarized. Apparatus and procedures employed are outlined and data are presented on the interpretation of diffraction patterns. Emphasis is placed in the discussion on the importance of combining electron diffraction techniques with microscopic, chemical, electrographic, and radiographic methods in order to obtain max information on the nature of surfaces. J. G. H.

186. Structural analysis of hydrocarbon polymers. 1. (In German.) J. C. Abrahamse, C. Boelhouwer, and H. I. Waterman. *BrennstChemie*, 1957, **38** (11–12), 183–5.—The properties of polymerization products of some saturated cyclic polymers are described. It is shown that the method developed for mineral oil investigation (ring analysis, *n–d–M* method) can be used in many cases. This arises from the fact that—especially in view of their degree of branching—these strongly cyclic polymers apparently do not differ much from natural mineral oil fractions. For the analysis of ring systems derived from phenol-resins the process mentioned gives incorrect results, probably on account of the linear character of these products. A modified analytical method in which the degree of branching is considered requires estimation of sp. ref. r^{20}_{spec} and sp parachor p. $p = \frac{\sigma^{\frac{1}{4}}}{d}$ (σ = surface tension/dyn/cm at 20° C). A disadvantage is the difficulty of accurate measurement of surface tension, especially of very viscous oils. Application of this method leads to adequate results for all polymers investigated, and permits a semi-quant estimation of their degree of branching. This revised method merits preference over other methods for structural analysis of cyclic hydrocarbon polymers. 19 refs. R. T.

187. Infra-red studies of bentone grease–water systems. E. C. Milberger, A. F. Miller, and V. R. Damerell. *NLGI Spokesm.*, 1957, **21** (5), 11–15.—Use of i.r. spectroscopy in the determination of water in bentone greases as a feature of a study of the mechanism of bentone grease gelation is discussed. Equipment and procedure employed are described, and interpretation of results obtained is discussed from standpoint of effect of water on physical properties of bentone greases examined. J. G. H.

188. Laboratory waxing machine. F. Walter *et al. Bull. Amer. Soc. Test. Mat.*, 1958, (227), 58–9.—ASTM tests for waxes, including blocking point, sealing and laminating strength, and gloss evaluation, call for the application of wax to paper in simulation of production conditions. Details are presented of the construction and operation of a machine developed by Pure Oil Co. for this purpose. J. G. H.

189. Refractivity intercept-density chart for the determination of total naphthenes in gasoline. S. Groennings. *Bull. Amer. Soc. Test. Mat.*, 1958, (227), 64–7.—The development of the refractivity-intercept graphical method for determination of total naphthene content of dist of gasoline boiling range is briefly described and a chart presenting the paraffin and naphthene curves in modified positions, resulting in certain advantages, is described and reproduced with data on its, construction. Present evaluation of this and other charts based on a limited number of experiments must be regarded as incomplete. J. G. H.

190. Chromatographic analyser for determining trace hydrocarbons in air separation plants. C. A. Gaulin *et al.* *Chem. Engng Progr.*, 1958, **54** (9), 49–53.—This instrument was developed and is in use at the ammonia plant control lab of the Atlantic Refining Co. in Philadelphia. In this plant by-product hydrogen from Catforming is combined with nitrogen separated from the atmosphere to produce ammonia. The analyser is used to monitor the hydrocarbon content of the liq air in the rich air vaporizers as well as in the atmosphere surrounding the plant. Individual paraffinic and olefinic hydrocarbons ranging in mol. wt. from C_2 to C_5, including acetylene, are determined on a routine basis at concn ranging from less than 0·01 up to 40 p.p.m. in *ca* one hour. Three chromatographic columns, which may be operated at temp from 0° C, or lower, up to *ca* 175° C, are included in the analyser. G. W. T.

191. A sensitive detector for gas chromatography. J. E. Lovelock. *J. Chromatog.*, 1958, **1**, 35–46.—The method of operation of the instrument described is based on the ionization properties of argon. This detector has a sensitivity which can be varied over a wide range and which will detect as little as 2×10^{-12} mol of most organic substances; it is relatively insensitive to temp, pressure, and gas flow rate. Details of the construction and operation are given. The detector has been maintained for many months at 200° and for several days at 245° without appreciable change in its response. Because change in ionization current with temp is small and regular, continuous alterations in temp are possible during the course of a chromatographic separation. G. W. T.

192. The application of gas chromatography to the analysis of natural gas. J. A. Favre, W. J. Hines, and D. E. Smith. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 27–32.—Gas chromatography has been applied to the analysis of natural gas. Hexamethylphosphoramide and molecular sieve columns are used. The inert and light hydrocarbon components through pentanes (or hexanes) are measured individually by peak height. The total hexanes and heavier hydrocarbons are measured by reversing the flow of carrier gas after pentanes and eluting the remaining hydrocarbons as a composite peak. The concn is determined from the area of this peak.

An analysis can be completed in less than an hour. The precision of the method is near 0·2% absolute for methane and 1–5% of the amount present for the minor components. The figures for accuracy are twice the precision. (Authors' abstract.)

193. Applications of gas chromatography in a crude oil production research laboratory. R. E. Styring, Jr. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 24–7.—Gas chromatography appears to be a promising analytical method for the analysis of gasoline plant products. Good results can be obtained in gas and volatile liq analysis by proper calibration and sample introduction techniques. The time required for an analysis is much less than that required for analysis by low temp fractional dist. Gas chromatography is more sensitive than low temp fractional dist for trace component analysis. (Author's abstract.)

194. Use of gas chromatography in a refinery laboratory. J. F. Hickerson. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 21–4.—Gas chromatography is used in one of Humble's Baytown service laboratories to analyse *ca* 2000 samples/month. Benzyl cellosolve has been found to suit their purposes best as a liq substrate. Use of automatic attenuators and calculation by peak height keeps manpower requirements to a minimum. Liq and gas samples C_2 through C_8 analysed routinely for individual isomers. (Author's abstract.)

195. Automatic chromatographic analysers for process monitoring and control. M. M. Fourroux. *Proc. 37th ann. Conv., nat. Gas Ass. Amer.*, 1958, 16–18.—The development of a peak reader with continuous output makes it possible to use automatic chromatographic analysers for process control. In a test run, a standard commercial chromatographic analyser, with a five-minute cycle, was coupled to the peak reader and used successfully to control a natural gas liquids debutanizer column. The analyser, measuring *iso*pentane on the ninth tray, controlled the stream flow to the reboiler through a temp recorder-controller on the fourteenth tray. This cascaded control system provided stable, sensitive quality control. (Author's abstract.)

196. Simple rapid method for direct quantitative analysis of dicyclopentadiene. (In German.) H. Ritter and F. Gude. *BrennstChemie*, 1957, **38** (11–12), 173–4.—By reaction of dicyclopentadiene with phenylazide an adduct is formed which —with glacial acetic acid—splits off a corresponding amount of N, which is measured in the apparatus illustrated. Absence of other substances which evolve N with acids is essential. *cyclo*Pentadiene does not react with phenylazide under the given conditions. Thus, dicyclopentadiene can be estimated in presence of $\geqslant 5\%$ of *cyclo*pentadiene, which is estimated in the original sample with maleic anhydrides. Trimers and higher polymerized *cyclo*pentadienes which react like dicyclopentadiene may not be present in the sample because they react also with phenylazide. Details are given of dicyclopentadiene estimation in tech dicyclopentadienes and old benzene first runnings, also in diluted solutions, *e.g.* light oil fractions. Check analyses on pure dicyclopentadienes are given. 7 refs. R. T.

CRUDE OIL

197. Overhauser effect in natural crude oil. E. Poindexter. *Nature, Lond.*, 1958, **182**, 1087.—The crude oil used in this expt has a visc of 40 cP and was assumed to contain *ca* 0·5% of colloidal asphaltenes of mol. wt. 20,000–40,000. The Overhauser interaction occurs between the asphaltene-free radicals and the hydrogen protons in the lighter hydrocarbons. The observed interaction is -ve, *i.e.* the nuclear polarization at first declines with increasing intensity of the radio-frequency field, becomes zero, then builds up in opposition to the applied field.

Calculation of the radical spacing and the proton relaxation times indicate that these rather large radicals are as effective in this respect as the much smaller radicals hitherto observed. H. C. E.

GAS

198. Processing of natural gas. J. M. Hollicky. *Canad. Min. metall. Bull.*, 1958, **51** (558), 630–3.—The economical processing of wet and sour natural gas presents a problem due to the seasonal demand for natural gas. The plants must be sized to handle the peak loads, but may only operate at half capacity on the average, in which case the sales value of sulphur and hydrocarbon liquid by-products cannot support the operating and capital costs of the plant. This must result in an increased price for the gas.

This problem was solved by Pacific Petroleum and Westcoast Transmission in the design of their pipeline and plant facilities now operating in the Peace River area, where there are both wet and dry gas fields. By building a plant to process sufficient wet gas to provide the base load requirement, and by drawing on the dry gas fields for peak loads, an optimum economic operation was possible. The sulphur, L.P.G., and gasoline produced are not only able to support the operating and capital costs of the processing plant but

were also instrumental in the sharp drop in retail prices of these commodities in the area.

The sour gas and condensate is gathered from the fields in the area and transmitted in a two-phase gathering system to the gas processing plant at Taylor, B.C. The condensate is knocked out in inlet scrubbers. Hydrogen sulphide and carbon dioxide are removed in an amine scrubbing unit. The hydrogen sulphide is stripped from the amine and is sent to the Jefferson Lake Sulphur Company's plant, which produces sulphur by the partial oxidation of the hydrogen sulphide. The natural gas, now sweet, is processed in an absorption unit to recover additional liquids, before being dehydrated to remove water. It is then sent to Westcoast's main compression station.

The condensate recovered in the inlet scrubbers and the liquid recovered in the absorption unit are fractionated to remove fuel gas, used in the plant, and to produce propane, butane, and naphtha. The propane and butane are scrubbed with caustic soda to remove hydrogen sulphide. The naphtha is treated with hydrogen in a unifiner unit to remove sulphur compounds completely, and is split into a light and heavy naphtha. The heavy naphtha is catalytically reformed to produce a high-octane blending component. These fractions are blended with components produced from crude oil at the Dawson Creek refinery to produce a high-quality balanced gasoline with special attention being paid to volatility for ease of starting, warm up, and engine cleanliness, and octane for power and performance. (Author's abstract.)

199. A method for predicting supercompressibility factors of natural gases. R. H. Zimmerman, S. R. Beitler, and R. G. Darrow. *Trans. Amer. Soc. Mech. Engrs*, 1958, **80** (7), 1358–62.—This paper shows the development of a working method which can be used to predict accurately the supercompressibility factors of natural gas mixtures in terms of gas properties which can be conveniently determined. A knowledge of three of the four independent values: (1) specific gravity; (2) heating value; (3) carbon dioxide content; (4) nitrogen content of any natural gas mixture, enables the supercompressibility factor to be evaluated using simple equations and a table of data based upon a reference gas of pure hydrocarbon composition and a sp. gr. of 0·600. The AGA Tables in Supercompressibility Factors for Natural Gas are based on this method. 9 refs. E. M. I.

200. Helium in natural gas in the Witwatersrand. S. H. U. Bowie. *Nature, Lond.*, 1958, **182**, 1082.—Natural gas from the underground workings of some gold/uranium mines has been found to contain 8% of helium, most of the remainder of the impurities being nitrogen. H. C. E.

201. Separation of gases in Soviet refineries. P. A. Smirnov. *Petroleum, Lond.*, 1958, **11** (8), 286–90.—The article aims to give a systematic account of the developments of the techniques for separating gases at Soviet refineries. Such an account of Soviet work has not been given before, and the paper should be of interest to both designers and those working on gas separation plants. M. F. M.

202. Natural gas in the first rank in Italian industry. C. Padovani. *Riv. Combust.*, 1958, **12** (9), 653–83.—A survey of the evolution through which Italian gaseous hydrocarbons have reached first rank among power sources and raw materials for synthesis available to Italian industry.

The various fields of application: automotive traction, boiler and industrial oven firing, electric power production, household uses, and chemical syntheses are reviewed.

The particularly sharp increase in the last three fields is emphasized. The chemical exploitation of natural gas, by synthesis based on carbon and hydrogen derivatives, is further treated in detail, with some mention of primary Italian achievements. (Author's abstract.)

203. Hydrocarbons in the manufacture of town's gas. Anon. *Petrol. Times*, 24.10.58, **62** (1597), 876.—Extracts are given from the Gas Council's report for year ended 31 March 1958, and include review of equipment for importation of liquefied natural gas by sea at Canvey Island for feeding to Romford for reforming, search for natural gas in Britain, gasification of oil at Isle of Grain by the Segas cat process, gas from oil refineries, and hydrogenation of coal and oil at high pressures, the plant for which latter will be at Partington with a final capacity of 15 million cu. ft. gas/day. G. A. C.

ENGINE FUELS

204. Use of temperature-density for measuring anti-knock quality. B. R. Siegel. *SAE Trans.*, 1958, **66**, 421–41.—The temp density concept used to measure fuels is explained in this paper. A lab engine was operated at constant fuel–air ratio and max power spark, with manifold air pressure used to stress fuels into the knocking zone. Data obtained was analysed to provide a single curve or formula expressing anti-knock quality or pre-ignition resistance at any combination of C.R., inlet temp, and manifold pressure. 14 practical applications are summarized, including suggestions for new control and aux test methods for studying knock and auto-ignition behaviour on a far wider basis than is possible by ASTM methods. G. W. T.

205. Vapour-locking tendencies of fuels—a practical approach. J. D. Caplan and C. J. Brady. *SAE Trans.*, 1958, **66**, 327–38.—A practical method of measuring and expressing the vapour-locking tendencies of gasoline has been developed. A modification of the Reid v.p. apparatus has been utilized. Development work was based on measuring the vapour pressure under assimilated conditions to those appearing in the fuel systems of passenger cars. The following advantages of the new method are indicated: it allows direct comparisons of vapour-lock test results of different reference fuel systems; establishes distribution curves of volatility requirements of cars for vapour-locking tendencies of gasoline; permits comprehension of the vapour-locking tendencies of both cars and gasolines by both petroleum technologists and automotive engineers, and also more realistically evaluates the effects of small weathering losses on vapour-locking tendency than does Reid v.p. G. W. T.

GAS OIL AND FUEL OIL

206. Selecting fuels for high-speed diesels. Anon. *Diesel Pwr*, 1958, **36**, 12–13.—This article is intended as a guide to the most economic commercially-available fuel, taking into consideration average engine load, average rev/min, and ambient conditions. An ASTM fuel classification table gives the specification for Nos. 1-D, 2-D, and 2 Fuels, and a fuel selection chart issued by the Detroit Diesel Div. of General Motors Corpn gives the dist, cetane, and sulphur limitations suitable for their engines under various conditions. G. W. T.

207. Bi-fuel approach to burning residual fuels in diesel engines. W. C. Arnold *et al. SAE Trans.*, 1958, **66**, 54–64.—The Sinclair bi-fuel combustion process is described; it is a process fundamentally different from either the dual-fuel gas or dual-fuel residual oil systems in its method of fuel utilization as well as its effect on engine operation. In tests run in one or more types of engines, favourable performance results were reported and can be summarized as follows. First, it permits low-quality fuels to be effectively burned under conventional engine operating conditions and at an acceptable exhaust-smoke level. Wear and deposits are reduced to a level considerably below that generally obtained

with low-quality fuels. It allows the smoke-limited power output of an engine to be increased. Permits operations on fuels normally not considered feasible or practicable in conventional diesel engines. G. W. T.

LUBRICANTS

208. State of dispersion of detergent additives in lubricating oil and other hydrocarbons. J. B. Peri. *J. Amer. Oil Chem. Soc.*, 1958, **35**, 110–17.—Sulphonated detergents present in hydrocarbon solvents (*n*-decane, *n*-dodecane, and *iso*-octane) are demonstrated by ultra-centrifuge and measurements to exist as micelles, 2 mol lengths in dia. The micellar size of Ca petroleum sulphonate changes with both temp and concn; electron microscopy demonstrates the possibility of larger particles co-existent with the smaller micelles. Sedimentation rates indicate that Aerosol D.T. (di-2-ethylhexyl Na sulphosuccinate) is present as a mono-disperse system, while Ca petroleum sulphonate exhibits a marked distribution of micellar sizes. G. W. T.

209. New lubricants and hydraulic fluids for high temperatures. E. D. Brown. *Mater. Design Engng*, 1958, **47**, 124–6.—This paper describes three new silicone fluids which can be used as hydraulic fluids or lubricants over a service temp range of −65° to 700° F; they are chlorophenyl methyl derivatives. Oxidative and thermal stability are discussed and comparison is made with other products. G. W. T.

210. Treatment of detergent lubricating oils. Anon. *Mot. Ship*, 1958, **39**, 270–1.—A summary is presented of the finding and recommendations resulting from research carried out by the de Laval organization, in collaboration with oil companies, on the centrifuging of detergent lub oils using three different methods, purification, clarification, and purification with water washing. Factors such as treatment temp, centrifuge capacity, degree of water contamination, etc., are dealt with. A review of the field for detergent-type oils is also included. G. W. T.

211. The stability of petroleum and synthetic lubricants to air impingement. (In Russian.) S. E. Krein and O. P. Makasheva. *Khim. i Tekhnol. Topliva i Masel.*, 1958, (8), 9–15.—The stability of petroleum oils to air impingement is not linked with their stability to oxidn and does not depend on their chemical composition. Essentially it is determined by the fractional composition or vapour tension of the oils. Highly viscous oils are the most stable to air impingement. The most stable of the synthetic oils tested contained esters of pentaerythritol and of diethylene glycol and fatty acids. Thickening of these esters with polymethacrylates allowed better visc–temp properties to be obtained and high stability to air impingement. G. W. T.

212. Mill and laboratory evaluation of oils for rolling of copper alloys. F. K. Reynolds. *Lubric. Engng*, 1958, **14** (3), 98.—Requirements for oils for rolling copper alloys are postulated as effective lub properties, minimum staining tendency during annealing process, and a sufficiently low demulsibility rating to facilitate separation during reclamation. Methods employed in the development of tests for mill use are discussed and the evolution from the data so obtained of adequate lab tests is described. J. G. H.

213. Storage stability of aircraft greases. H. Schwenker. *NLGI Spokesm.*, 1957, **21** (4), 10–14.—Storage stability tests of soap–diester, soap–petroleum, and soap–silicone greases under simulated desert storage, room temp storage, and simulated tropical storage conditions are reported. Soap–diester greases showed no substantial change in consistency under any conditions. Soap–silicone greases showed hardening tendencies over first 24 months storage at 130° F, beginning, however, to soften somewhat after 30 months, a similar tendency at room temp after 24 months being followed by no resoftening. Soap–petroleum greases showed little change in consistency under tropical conditions. It was not found possible to correlate changes in consistency with changes in other chemical and physical properties under these conditions. J. G. H.

214. Cutting fluid performance. H. W. Huss and W. L. Bulkley. *Lubric. Engng*, 1957, **13** (10), 557–62.—Necessity of composite measurements in the evaluation of cutting fluids is emphasized and a test method is described which uses tool-wear rate, surface finish, and cutting temp. Use of radio-active material in measuring tool-wear rate is discussed and necessary personnel precautions indicated. Techniques used for obtaining surface-finish data and cutting temp are described and statistical treatment of data obtained, using compounded and mineral oils in the machining of four standard steels, is explained. 9 refs. J. G. H.

215. Threading test for cutting oil evaluation. H. A. Hartung, J. W. Johnson, and A. C. Smith, Jr. *Lubric. Engng*, 1957, **13** (10), 538–42.—Advantages of using thread cutting process as a means of evaluation of cutting fluids are enumerated and details of the method and equipment used are presented. Control of such variables as chaser quality, threading speed, flow of cutting fluid, and visc effects are discussed, and the geometry of threading processes is explained. Application of the test to the evaluation of additives is described, and correlation with field service is tabulated with details of limitations in processes other than thread cutting. 11 refs. J. G. H.

216. New reflex rating technique for the performance assessment of oils. W. G. Bold and P. W. Harrison. *Sci. Lubric.*, 1957, **9** (12), 16–23.—Present methods of rating motor oils by comparison of piston conditions are briefly indicated, and details are presented of the development and procedure employed in a new method whereby reflex photography is used to obtain a panoramic view of the piston skirt. Equipment and processing methods employed are discussed and the interpretation of prints so obtained is explained. The particular suitability of this method for lacquer rating is emphasized. J. G. H.

217. Marine diesel engine lubrication. G. H. Clark. *Sci. Lubric.*, 1958, **10** (3), 12–19; **10** (4), 31–3.—Pt 1. Special difficulties encountered in the lubrication of marine diesel engines are enumerated, causes of cyl wear are discussed, and requirements for adequate cyl lubricants are set out. Effects of high sulphur fuels on engine operation are considered, together with abrasive wear and increased liner and piston ring wear resulting from the use of low cost fuels. Data on the latter problem obtained from the operation of Harland, B. & W., and Doxford engines using conventional cyl oils are presented. 8 refs.

Pt 2. Causes and effects of ring-zone deposits are discussed. Cyl lubricants comprising a blend of 10–30% of paraffinic bright stock to a medium visc base oil, having a visc of 160–250 sec. Redwood 1 at 140° F cover most manufacturers' recommendations. Practical methods of reducing engine wear when operating on residual fuels discussed include selection of materials for liners and piston rings, chromium plating of liners, injector design, fuel cleaning methods, and cooling procedures. J. G. H.

218. Effect of additives on crankcase oil filterability. R. L. Willis and E. C. Ballard. *Lubric. Engng*, 1958, **14** (2), 58.—Advantages of decreasing rate of sludge deposition on engine oil filters are set out, and the possibilities of increasing filter life by careful selection of detergent incorporated in crankcase oils is indicated. Details are presented of an investigation of

relative merits of detergent additives using both lab and road tests. Lab and road procedures are described, and results obtained indicate that engine tests can differentiate between additives in effectiveness in minimizing filter plugging, correlations between lab and road tests are possible, and ashless detergents show to advantage in both sets of tests. 14 refs. J. G. H.

219. Field study of gas engine lubricants. C. M. Floyd. *Lubric. Engng*, 1957, **13** (12), 647–50.—Details are presented of a test programme investigating the use of a wide variety of oils in different types of gas engines. Naphthenic and paraffinic base oils are used as uncompounded, mildly detergent, and highly detergent lubricants. Engines and procedures used as described, and used oil tests are discussed. Results obtained indicate that in two-cycle engines in mild service non-detergent naphthenic oils are superior to paraffinic types, and increased severity of service calls for detergent oils. In four-cycle engines paraffinic types proved most effective, with, however, little difference between the two at higher detergency levels. Used oil tests showed little correlation with engine cleanliness. J. G. H.

220. Experimental investigation of railroad journal bearing operating characteristics. A. L. Busby and G. L. Pigman. *Lubric. Engng*, 1957, **13** (10), 546–52.—As part of a programme of investigation of railroad freight car hot box problems, details are presented of apparatus and procedure employed in measurement of the coeff of journal friction and oil flow through the bearing for successive stages of seating of 6-inch × 11-inch babbit railroad journal bearings. Results so obtained indicate that performance characteristics of the bearing do not change significantly with further wear after a seating width of *ca* 2 inches is established and that the time required to obtain this minimum seating is increased with the use of large initial clearance. The 200 miles in railroad service required to obtain suitable seat width in a bearing with initial 0·015-inch radial clearance has been accepted as standard by Association of American Railroads. Measured friction agrees reasonably closely with computed values based on oil film cavitation, whereas theoretical friction curve based on negative oil film pressures shows considerable deviation for conditions of large bearing loading. J. G. H.

221. Technical considerations in the marketing of rear axle lubricants. C. M. Heinen. *NLGI Spokesm.*, 1957, **20** (10), 17–22.—The background of U.S. Army Spec. 2–105B for universal gear lubricants is briefly indicated and the relation between axle tests included therein and CRC procedures L-19 and L-20 is discussed in some detail. Developments leading up to the formulation of CRC procedure L-37 to replace the L-20 high torque test are outlined, and tabulated data comparing the L-20 and proposed L-37 tests are presented. J. G. H.

222. To pack—or not to pack—effect of packing procedure on wheel bearing performance. E. O. Forster, J. J. Kolfenbach, and J. Panzer. *NLGI Spokesm.*, 1957, **21** (7), 24–8.—The recommendation in the NLGI's "Recommended Practices for Lubricating Automotive Front Wheel Bearings" that wheel hubs should not be packed with grease has occasioned wide controversy. Details are presented of an investigation of the question using field tests on a wide range of automotive equipment operating under severe driving conditions, the whole programme being designed on a statistical basis. Equipment and procedures used are described, and results so obtained confirm correctness of original recommendation. J. G. H.

223. Preparation of highly effective rust inhibitors by fractionation of mahogany sulphonates. K. R. Fisch, J. Messina, and H. Gisser. *Lubric. Engng*, 1958, **14** (2), 64–7.—Effective rust inhibitors capable of meeting the requirements of military specifications are being prepared by the fractionation of commercial mahogany sulphonates. Materials and methods of fractionation employed are described, and rust tests run in a cyclic humidity cabinet are reported. Correlations observed between rust-preventive effectiveness and equivalent weights and between i.r. curves and equivalent weights indicate that differences among the fractions occur in size and possibly in configuration of the alkyl side chain and in the number of naphthenic rings. J. G. H.

224. Theory of oil-whip for vertical rotors supported by plain journal bearings. F. Ørbeck. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (7), 1497–502.—This paper tries to show that by considering the force equilibrium of the journal in a journal bearing subjected to oil-whip, two equations can be deduced which describe oil-whip in frequency and amplitude. The forces considered are pressure in the oil film, viscous drag by the oil film, and centrifugal force due to whirling motion. The first equation determines ratio of frequency of whirl to frequency of rotation in terms of the eccentricity ratio, the second relates the eccentricity ratio to the frequency of rotation. It was assumed that the journal moved in a circular path with constant velocity and is therefore not a general analysis of oil-whip. 3 refs. E. M. I.

225. Methods of testing filter performance and characteristics of some types of filters. E. A. Stokes and G. H. Vokes. *Sci. Lubric.*, 1958, **10** (1), 12–19.—The importance of lubricant filtration in the reduction of wear is emphasized, and the value of air filtration for the same purpose is indicated. BSI air filter test is summarized, and the types of air filters in general use are described in some detail. The respective functions of partial and full flow oil filters are explained and illustrated, the main types of full flow filter media, felt and paper, are discussed, and details are presented of procedures for testing fuel and lub. oil filters. J. G. H.

226. New problems—new oils. J. V. Kalb. *Diesel Pwr*, 1958, **36** (8), 24–6.—This paper gives the results of wear tests using H.D. and emulsion-type oils in a large, five-cyl low-speed two-stroke trunk-piston engine burning heavy fuels. The engine was planned so that individual cyl could be lubricated with different oils, therefore allowing direct comparisons of wear rates for liners and piston rings. The data demonstrate that substantial reduction in wear was achieved. G. W. T.

227. Valve train wear as affected by metallurgy, driving conditions, and lubrication. V. Ayres *et al.* *SAE Trans.*, 1958, **66**, 243–51.—This paper is a report of tests carried out in 1956 by the Camshaft and Valve Tappet Wear Group of the Co-ordinating Research Council. Cam and tappet wear, spalling, and scuffing in field service were all investigated as functions of valve-gear design, lubricant properties, and type of operation. Some of the results reported by the Group are: (1) oil-compositions had considerable effect on cam and tappet wear when chilled-cast-iron or steel tappets were used; (2) only chilled-cast-iron tappets showed an appreciable spalling tendency; (3) tappet scuffing is more dependent on metallurgy design than on oil composition; (4) indications pointed to tappet spalling being related to the rate of wear; (5) cam scuffing was not a widespread problem. G. W. T.

228. Modern problems in friction and lubrication. D. Tabor. *Nature, Lond.*, 1958, **182**, 980.—Report of five papers presented to Sections A and G of the British Association, Glasgow, Sept. 1958.

With some metals the friction decreases as the sliding speed of the surfaces increases, until at 2000 m.p.h. the surfaces behave as though they were lubricated. In ordinary sliding,

friction is due to: (1) shearing of interfacial junctions; (2) grooving or deformation of the softer surface. Cases in which the latter is of dominant importance were discussed.

The changes in lubricants and greases resulting from high-energy irradiation were explained.

The classical theory of hydrodynamic lubrication has been shown to be deficient in four respects, which were discussed. The conditions of instability of load on bearings and the resulting problem of lubrication is described. Four " rules of wear " during a test were described. H. C. E.

229. Lubrication of rotary high vacuum pumps. 2. A. C. Smith. *Sci. Lubric.*, 1957, **9** (11), 12–16.—The performance of gas-ballasted and of hot pumps is discussed, and methods for oil preservation and contamination prevention are indicated. Vapour pressures of the order of 10^{-5} to 10 mm^{-8} Hg at 20° C are called for, and relations between visc and vapour pressure are discussed. Suitable oils for general use are indicated, and circumstances which render the use of h.d. oils unsuitable are set out. J. G. H.

230. Fog lubrication of machine tools. D. G. Faust. *Lubric. Engng*, 1958, **14** (2), 54–7.—Fundamental principles of lubrication of bearings by aerosols are briefly indicated, and the equipment and accessories employed are described. The use of the term " bearing inch " as a means of evaluating lubrication requirements of machine elements is discussed, and methods of calculation for the more common components are set out. Advantages accruing from use of aerosol lubricants are tabulated and typical applications illustrated. J. G. H.

231. Paper mill lubrication. Anon. *Lubrication*, 1958, **13**, 261–76.—Essential lubricant requirements for paper production service are presented with numerous plant illustrations. In modern operation lubricants are subjected to relatively high temp, high loads, and heavy water contamination. Characteristics imposed on a satisfactory lubricant for this service are increased load-carrying capacity at high temp to insure against bearing failure, high oxidn resistance to ensure extended life at high temp, excellent rust protection to minimize bearing corrosion, detergent and dispersant qualities to prevent hard carbonaceous deposit formation in the bearings. Use of premium lubricants and a thorough maintenance programme are indicated. R. T.

232. Russian research on lubrication and wear. D. Godfrey. *Lubric. Engng*, 1958, **14** (1), 27–31.—An outline is presented of the organization of research in Russia, with details of Russian scientific publications and of translation services available in the U.S.A. 11 translations of recent (1951–56) Russian papers on the action between lubricants and additives are reviewed and Russian and Western research procedures in this field are compared. J. G. H.

233. Apparent absorption isotherms of oleic acid from hydrocarbons as obtained from coefficient of friction measurements. A. Miller and A. A. Anderson. *Lubric. Engng*, 1957, **13** (10), 553–6.—Data are presented of an investigation of the lubricating behaviour of dilute solutions of oleic acid using the friction pendulum, discussing this as a function of temp and relating it to the adsorption of a monomolecular film. The apparatus and procedure used and results obtained are discussed and put forward as being of possible value in the rapid determination of relative merits of various surfactants for reducing the coeff of friction. 15 refs. J. G. H.

234. Evaluation of grease lubricated bearings at high rotative speeds. J. R. Roach and T. B. Jordan. *NLGI Spokesm.*, 1957, **21** (2), 18–22.—Bearing rigs developed by the Texas Co. for the testing of greases for lubrication of high-speed bearings are described and illustrated. These comprise a rig utilizing 20-mm bore bearings mounted in a cradle and coupled to an electric motor by means of an Erickson collet and a necked-down shaft and a grinding spindle, belt driven at 35,000 rev/min with a $\frac{3}{4}$-h.p. motor, used as a high rotative test unit. Effects of bearing operating temp and of bearing design on performance of grease lubricants are discussed. J. G. H.

235. Kel F. No. 90 grease: a chemically and thermally stable fluorocarbon lubricant. R. J. Seffl, F. W. West, and F. J. Horn. *NLGI Spokesm.*, 1957, **2** (3), 22–5.—Kel F. No. 90 grease, a fluorocarbon product developed by Kellogg Co., is particularly effective in the lubrication of process equipment under extreme thermal and corrosive conditions. Physical and chemical properties are presented, lubricating properties are discussed in some detail, and fields of successful application are indicated. J. G. H.

236. Effect of vibration frequency and amplitude on ball joint grease steering performance. M. C. Goodwin and N. A. Hunstad. *NLGI Spokesm.*, 1957, **21** (1), 10–16.—Present ideas of inadequacy of modern commercial chassis greases are reviewed and variations in road conditions encountered are illustrated by a series of records of road test vibration measurements. Based on the instruments used in obtaining these records, a bench test, utilizing an automotive suspension ball joint, has been developed for the evaluation of chassis grease performance. The equipment and procedures used are described, and from data so obtained, using a single commercial calcium base grease, an increase of torque is shown during vibration at small amplitudes; limited range of data available provides reasonable correlation with deterioration in ride and handling qualities as observed by chassis engineers. Necessity for extended investigation is emphasized. J. G. H.

237. Problems associated with grease lubrication of high speed–high temperature bearings. H. Hanau. *NLGI Spokesm.*, 1957, **20** (12), 10–14.—Increasing severity of demands made upon ball bearings in modern aircraft equipment have resulted in a changeover from grease to oil lubrication in the interests of long service life. Details of power turbine installations tested and of equipment and procedures employed in a high speed–high temp programme of bearing development are presented, and stress is laid on the necessity for continuing work on the development of greases which will satisfactorily lubricate such bearings. J. G. H.

238. Basic factors in the formation and stability of non-soap lubricating greases. I. Study of the factors responsible for gel formation. G. T. Young and J. J. Cheswick. *J. Coll. Sci.*, 1958, **13**, 358–71.—The nature and extent of the oil-thickener interface has been examined for combinations of eight synthetic and mineral oils with 16 thickening agents. The surface area (A), av. particle size, particle shape, heats of immersion, and water adsorption of the thickener were measured. For hydrophobic thickeners of A >200 m^2/g grease building efficiency depends directly on A. For those of less A the efficiency falls off sharply. The amount of thickener required to give a grease of specified consistency varies as $1/A^2$. For hydrophilic thickeners the consistency is controlled by the water adsorption, which is much greater than for hydrophobic thickeners. The amount of water at the interface is affected by temp, R.H., and previous working of the grease. For hydrophobic thickeners the polarity of the oil has little effect on the grease-building properties. For hydrophilic thickeners, water enhances thickening in non-polar oils, but decreases it in polar oils.

II. Mechanism of gel formation. A. C. Zettlemoyer and G. T. Young. *Ibid*, 372–82.—Hydrophobic and hydrophilic particles of large A flocculate in pure or dry liq to form grease gels by particle contact, and the degree of polarity of the liq is of minor importance. However, if traces of water

are present, the flocculation of hydrophilic thickeners is markedly affected, but it does not affect the flocculation of hydrophobic thickeners. Water enhances flocculation in non-polar liq but decreases it in polar liq.

Addition of 4% heptyl alcohol or heptylamine drastically thins greases built with polar solids; the aldehyde, chloride, and acid have little effect. The effect increases as the polarity of the solid is increased. In the presence of the additive and water the degree of surface polarity determines whether either component will be displaced by increasing concn of the other component. H. C. E.

239. Metal carbonates coated with salts of low molecular weight polycarboxylic acids as grease thickeners. E. W. Nelson *et al.* *NLGI Spokesm.*, 1957, **21** (6), 13–17.—A grease thickener is described consisting of a colloidal dispersion of a polyvalent metal carbonate coated by chemical interaction with a low mol. wt. polycarboxylic acid which has proved promising in greases over a −100° to +350° F range in aircraft lubricants. Choice of synthetic base oils is discussed; silicate esters have proved most effective. J. G. H.

240. Manufacture of lithium soap grease and calcium soap grease by electric heating. D. F. Rhodes. *NLGI Spokesm.*, 1957, **21** (6), 18–24.—Canadian Oil Co.'s plant at Montreal for manufacture of lithium and calcium soap greases is described and illustrated. Electric heating is effected by use of heat transfer oil, a 200 S.U.S. at 100° F solvent treated paraffinic oil being used. Data on equipment, processes, heating media, and economic aspects are presented in tabular form. J. G. H.

241. Predicting high temperature performance of lubricating greases. J. L. Dreher. *NLGI Spokesm.*, 1957, **21** (2), 13–17.—Limitations of conventional test methods for screening greases are remarked and details are presented of a screening test for high temp performance developed by California Research Corpn. A thin film of grease is spread on a steel strip, which is then deposited horizontally in an oven maintained at the desired test temp, the sample being inspected at appropriate intervals for retention of its grease-like properties. Correlations of test with bearing test and field results has proved satisfactory, and proposals for extending its usefulness are discussed. J. G. H.

242. Influence of base oil characteristics on the performance of anti-friction bearing greases. H. A. Woods. *NLGI Spokesm.*, 1957, **20** (12), 16–19.—Increased performance requirements for high temp bearing lubricants are illustrated by changes in military specifications for such products. Development of such greases has recently been facilitated by development of short time screening tests for oxidn stability. These, an oxidn absorption test, a thin film oxidn test, and a new short time bearing test, are described and illustrated. The effect of volatility on bearing performance is described, together with the special properties of synthetics for extreme high temp greases and the specific limitations of silicones in this connexion. J. G. H.

243. Grease flow in shielded bearings. R. O'Halloran, J. J. Kolfenbach, and H. L. Leland. *Lubric. Engng*, 1958, **14** (3), 104.—Mechanism of grease lubrication of shielded bearings was investigated by the use of dye tracers for the grease as a whole and for the oil component, amounts present being measured before and after bearing operation. Procedure and dye tracers used are described, and results obtained, although of a limited nature, indicate that grease moves between bearing and shield as an entity. Data presented in the discussion based on radioactive tracer techniques indicated considerable separation out of the oil component and emphasized need for further investigation of the problem. J. G. H.

244. New synthetic thickener for multi-purpose lubricating grease. J. L. Dreher, B. W. Hotten, and C. F. Carter. *NLGI Spokesm.*, 1957, **20** (11), 10–15.—Details are presented of a series of tests on a new thickener for multi-purpose grease, sodium *N*-octadecyl terephthalamate, developed by California Research Corpn. Lab tests covering high temp properties, water resistance, compatibility, work stability, oxidn resistance, low temp properties, and rust prevention are recorded, together with work on applications in silicone and other synthetic greases. J. G. H.

245. Some aspects of bentone greases. R. E. Fariss. *NLGI Spokesm.*, 1957, **20** (10), 10–16.—Development of bentone greases, involving dispersion of bentonite in base oils, is summarized. Earlier methods of dispersion are discussed, together with the use of low mol. wt. polar cpds, type of base oil used, and conditions required for optimum gelation. J. G. H.

246. What's in a name: definition of terms relating to the lubricating grease industry. W. J. Ewbank. *NLGI Spokesm.*, 1957, **21** (6), 9–11.—A brief survey of the development and activities of the NLGI Cttee on Definitions is followed by a first series of approved definitions comprising 19 terms. J. G. H.

247. Method for the prediction of hardness changes of greases in storage. G. W. Eckert. *NLGI Spokesm.*, 1957, **21** (5), 17–22.—Importance of knowledge of hardness changes in greases during storage period is emphasized and previous work on age hardening tendencies is briefly reviewed. Necessity for an accurate age hardening test is remarked and details are presented of such a test using the ASTM oxidn bomb, which showed good correlation with full-time storage tests. Test provides in one day equivalent to 2·4 months in normal storage test for hardness changes on an unworked basis. J. G. H.

248. Service experience with a new multi-purpose industrial grease. S. R. Calisch. *Lubric. Engng*, 1957, **13** (12), 640–6.—Characteristics and advantages of multi-purpose industrial greases are briefly summarized and the properties of a terephthalamate multi-purpose grease employing sodium octadecyl terephthalamate as thickener are set out. Service experience with this grease is recorded from the standpoints of high temp performance, effectiveness under conditions of heat plus moisture, rust-protective properties, resistance to excessive working, and pumpability and possible directions for improvement of the grease are indicated. J. G. H.

249. Theory of thixotropy and its application to grease. S. J. Hahn, T. Ree, and H. Eyring. *NLGI Spokesm.*, 1957, **21** (3), 12–20.—The Ree–Eyring theory on non-Newtonian flow is discussed together with the derivation of the Ostwald flow curve and the thixotropy curve. Applications of the thixotropy theory in the grease field are discussed together with the mechanism of polymer additives as pour-point depressants and V.I. improvers. 20 refs. J. G. H.

BITUMEN, ASPHALT, AND TAR

250. Fundamentals on roof design with bituminous coverings. Pt I. (In German.) A. W. Rick. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (7), 250–3.—Often neglected fundamentals—important for roof construction—are discussed. Numerous factors—more marked on massive flat roofs—affect the stability of the bitumen covering. The chief factors affecting the roof skin are external and internal vibrations, moisture migration, and heat movements under the sun's effects. These are discussed in detail and preventive measures suggested. R. T.

251. Temperatures of bituminous roof-surfaces. E. R. Ballantyne and J. W. Spencer. *Bull. Amer. Soc. Test. Mat.*, 1957, (223), 69–73.—Importance of temp and rate of temp changes as factors affecting the durability of bituminous roof surfaces is emphasized and present shortage of data on this subject is remarked. Details are presented of an investigation of the problem carried out near Melbourne, Australia, on pitched and flat roofs covered with a black bituminous surface and subjected to various surface treatments. Procedures employed are described, and data so obtained indicate that greatest reductions, up to 15° F, were obtained by treating flat black bituminous surfaces with a suitable white reflective coating. Reductions obtained with aluminium paints were not so large; those obtained on pitched roofs were larger. J. G. H.

252. Asphalt lining of radiochemical waste storage basins. C. D. Watson, A. J. Hoiberg, and G. A. West. *Industr. Engng Chem.*, 1958, **50** (8), 87A–90A.—Waste solutions and coolants from atomic power and research reactors vary in radioactivity from 10^{-4} to 10^{2} curies/litre. Storage of such highly radioactive and corrosive liq present special problems. Storage times vary from a few years to many centuries for radioisotopes of long half life such as strontium.

Use of asphaltic lining for radioactive waste containers has proved successful in the past few years, and since 1947 over 9,000,000 sq. yd of asphaltic membranes have been used. The effect of temp, radiation, corrosive acids, and vibratory movements on the asphalt lining is discussed in the article. Cost of constructing a 1,000,000-gal lined earth basin for the retention of radiochemical waste solutions has been estimated to be $0·03/gal when sprayed lining or prefabricated plank is used. Limiting testing of prefabricated asphaltic membranes indicates poor resistance to both acids and alkalis. M. F. M.

SPECIAL HYDROCARBON PRODUCTS

253. Preparation of white vaselines and ceresines by refining hydrogenation. (In Czech.) S. Landa and J. Mostecky. *Chem. Prom.*, 1957, **7**, 393–7.—Tungsten disulphide was used as a cat in this reaction, and the process was carried out in one stage. The temp of hydrogenation was accurately determined both in autoclaving and for a continuous flow: yields were almost theoretical, and products of high quality were produced. 60 refs. G. W. T.

254. Detection of polycyclic aromatic compounds in hydrocarbon waxes. (In German.) W. Presting and S. Janick. *Fette Seif. Anstrichmittel*, 1958, **60**, 12–16.—Microscopical examination, using polarized and u.v. light of model mixtures of several commercial waxes and polycyclic aromatic cpds (picene, triphenylmethane, anthracene, and pitches of m.p. 198°, 283°, and 297°) indicated a characteristic crystalline formation, which might be employed for the detection of such mixtures. G. W. T.

255. The relation between composition and blocking temperature of paraffin waxes. K. G. Arabian. *Tappi*, 1958, **41**, 275–80.—Blocking temp is a function of wax compositions which can be varied by the processing methods used in lub oil dist or wax manufacture. The most effective way to improve blocking temp, without raising the m.p. of the wax, resulted from the preparation of wax fractions with a narrow mol. wt. range. When the de-oiling temp of crude paraffin wax was raised from 40° to 70° F it resulted in a slight improvement in blocking temp, a decrease in yield, and changes in other performance tests which render the wax unsuitable for most commercial applications. Variations in the hydrocarbon composition without a change of the mol. wt. range resulted only in minor changes in the blocking temp. The presence of *n*-alkanes of low m.p. had a harmful effect on the blocking temp, but low m.p. non-normal alkanes were no more harmful than *n*-alkanes of the same m.p. G. W. T.

256. Composition *v.* properties of microcrystalline waxes. W. P. Ridenour *et al.* *Tappi*, 1958, **41**, 257–67.—Three commercial grade microcrystalline waxes were treated with urea, and the resulting adductible and non-adductible portions were further separated into narrow fractions by mol dist and thermal diffusion. Functional properties such as tensile strength, hardness, blocking point, sealing strength, moisture vapour permeability, and flexibility were determined for the commercial waxes and for the urea-adductible fractions. An attempt was made to correlate the results of functional tests with the physical properties. Blocking, hardness, and tensile strength were adversely affected by increasing concn of branched-chain paraffins. Sealing strength and flexibility were improved by increasing concn of cyclic and branched paraffins. G. W. T.

DERIVED CHEMICAL PRODUCTS

257. Synthetic rubber production in the U.K. Anon. *Petrol. Times*, 24.10.58, **62** (1597), 863; *Inst. Petrol. Rev.*, 1958, **12** (144), 398–9.—The new plant at Hythe of the International Synthetic Rubber Co. has a total capacity of 70,000 tons p.a.

The monomers butadiene and styrene are treated to remove inhibitors, then fed to reactors for emulsion type polymerization, reaction mixture consisting of the two monomers, water, an emulsifying agent, cat, reaction moderator, and activator. Unconverted monomer is recovered, and the rubber product coagulated, screened, washed, filtered, dried, then pressed into 80-lb bales. A flow diagram is given. G. A. C.

COAL, SHALE, AND PEAT

258. Shale oil nears competitive level with domestic petroleum. E. P. Miller and R. J. Cameron. *J. Petrol. Tech.*, Aug. 1958, **10** (8), 25–7.—Most current work is on the retorting phase of oil shale processing; refining technology has developed to a suitable stage, and the mining work at Rifle has given basic data. The Union Oil retort has downflow of hot gas with upward passage of shale, whereas the reverse is the case for the USBM gas combustion retort. The Aspeco process has two rotating kilns, one for pyrolysis of raw shale, the other for burning off carbon. Both use balls for heat transfer.

On the basis of 1957 prices and 6% return on investment, it is estimated that Colorado shale could give gasoline in S. California at 19 c/gal, compared with 14·15 c/gal for gasoline from petroleum.

A comparison of the Union and USBM retorts for 250,000 b.d. crude shale oil, with 12% return and 15% depletion allowance, gives $3·95/brl for the former and $3/brl for the latter. The gas combustion retort costs are approaching present crude oil prices. Investment per brl of crude shale oil delivered in California may be much less than for new crude oil found and produced. G. D. H.

259. Union Oil's shale programme—progress report. F. L. Hartley and J. E. Hines, Jr. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 68–82.—Goals of Union Oil's oil shale research programme are shown to include the development of an effective continuous method of heating crushed oil shale in a retort in order to recover bitumen; the solution of the related problem of continuous rock movement through the retort, as well as development of a system for optimal energy recovery from the raw material, including appropriate refining processes and by-product considerations.

Union Oil's shale demonstration plant near Grand Valley,

Colorado, is described. Progress in various areas of the research programme is discussed. The need for a new domestic source of petroleum products is outlined, both from the standpoint of the ability of shale oil to compete with crude oil economically and from military considerations.

The need to establish a depletion rate for oil shale equitable with those depletion rates now allowed for oil and gas from wells is stressed.

Water requirements for a potential oil shale industry are described. (Authors' abstract.)

CORROSION

260. A close look at filiform corrosion. J. D. Sudbury, O. L. Riggs, and J. F. Leterie. *Oil Gas J.*, 8.9.58, **56** (36), 118.—Filiform corrosion in a variety of alkanol–amine systems is characterized by a highly directional corrosion beginning at a sharp edge growing rapidly in the form of thin thread-like filaments, the metal surface beneath the filament being severely corroded. Of various inhibitors tried, only the condensation product of polyethylene amines and saturated alcohols was effective. Tables show effect of various chemical additives in two typical amine purification systems. G. A. C.

261. Design and installation of cathodic protection. Pt II. N. P. Pfeifer. *Pipe Line News*, 1958, **30** (10), 48D.—To determine whether or not a pipeline is affected by cathodic interference one of the two methods described can be used.

Direct method—this involves returning the potential of the line to the potential that existed prior to the installation of the cathodic protection. The term used is Static Potential (*Vg*).

Modified direct method—the procedure is basically the same but slightly modified to enable several lines to be tested simultaneously.

In using these methods, a sensitive voltmeter with a high input resistance, a shunt, a millivoltmeter, and a copper–copper sulphate electrode is required. The operating costs are discussed, and forms of ground bed installations for various pipes are described. M. F. M.

262. External cathodic protection of ship's hulls. Anon. *Petrol. Times*, 12.9.58, **62** (1594), 770.—A current system invented by Cathodic Corrosion Control Ltd uses CX3 lead alloy as anode material and makes power-impressed external cathodic protection economical and convenient. A diagram shows method of mounting of anodes. G. A. C.

263. Accelerated high-temperature oxidation (in gas turbines) due to vanadium pentoxide. K. Sachs. *Metallurgia, Manchr*, 1958, **57**, 123–37, 167–73, 224–32.—The incidence of V_2O_5 in the combustion ash from gas-turbine fuels, particularly residual oil, is discussed, and an extensive review is made of previous works-scale and lab studies of the effect of V_2O_5 in causing corrosion and fouling on metals used in gas turbines. Work on the mechanism of attack and on preventive measures is also summarized; no full protection has been devised up to the present. Possible alternative fuels are discussed briefly. 123 refs. G. W. T.

ENGINES AND AUTOMOTIVE EQUIPMENT

264. Fuel consumption measurement. Anon. *Auto. Engr*, 1958, **48**, 312–13.—Provides a description of equipment developed by Farrell Instruments Ltd, for lab or engine test purposes. The basic measuring devices comprise a burette (either 157·8 cm^3 or 1578 cm^3); a Dowty revolution counter reading up to 999 999; and a Synclock time interval meter. Electronically, the circuit consists of four lamps and their associated photo-electric cells, with the requisite amplifiers and energizing relays. The sequence of operations is outlined, accompanied by a diagram. G. W. T.

265. Supercharged boilers for marine application. E. L. Daman. *Trans. Inst. mar. Engrs*, 1958, **70** (7), 241–59.—General design considerations for the steam boiler component of supercharged or combined gas turbine steam boiler plants. Weight, space, and performance comparisons are made with conventional boilers, showing them to be attractive. Experience so far has been with dist oils, but the author outlines lab tests and results for use of residual oils with additives to prevent corrosion and ash accumulation. These show promise when using Mg–Al additives. The problem of matching a supercharger set to supercharged boiler for optimum effectiveness is considered, with an example of the effects of mismatching. E. M. I.

266. Automotive gasoline injection. C. N. Nystrom. *SAE Trans.*, 1958, **66**, 65–74.—This paper covers the basic engine requirements for the gasoline-injection system; the principal advantages achieved with fuel injection for passenger-car and truck engines, together with a report on a successful field test of a gasoline-injection car participating in a trans-continental economy run. It also includes a detailed description of the components and operations of the American Bosch injection system. G. W. T.

267. Automotive exhaust hydrocarbon reduction during deceleration by induction system devices. Induction System Task Group, Automobile Manufacturers Association. *SAE Trans.*, 1958, **66**, 383–96.—This paper is a progress report of the work carried out from 1955 to mid-1957 by the above group. Two types of devices are described, those which stop the flow of fuel from the carburettor during the deceleration cycle, and those which maintain combustible mixtures during deceleration. The effectiveness of such devices is, however, limited. Data from Los Angeles traffic surveys indicated that hydrocarbon emission during deceleration is considerably less than reported by early investigations and that relatively low speed decelerations predominate in traffic. In addition, the wide variety of engine installations and carburettors in use to-day obviate the possibility that one device could be suitable for universal adaptation. The Group concluded that the principle of the vacuum limiting type of device appears to be the best approach to this requirement. G. W. T.

268. Philosophy of telecontrol of reciprocating gas engine compressors. F. V. Long. *Pipe Line News*, 1958, **30** (10), 39–48.—The paper includes a general discussion of telecontrol of reciprocating gas compressor stations and discusses specifically the Linden (N.J.) station of Texas Eastern Transmission Corpn, which marks the first use of unattended operation of a large reciprocating compressor.

In order to control a reciprocating station remotely, the manual functions normally performed by station operators must of necessity be accomplished by automatic means.

(1) Main valves have gas-operated operators equipped with limit switches. Unit suction, discharge, and recycle valves are all automatically opened and closed in proper sequence by means of solenoid valves.

(2) Engine controls, such as starting air, jet air, pocket, cyl valves, fuel gas, etc., are operated with electric solenoid controls. Adjustment of cooling water valves, oil valves, hydraulic oil valves, etc., is accomplished by means of automatic valve operators. Engine ignition system is independent of a.c. power and includes automatic spark control.

(3) Detection devices are incorporated to replace some of the critical features of the uses of the operators, such as monitoring valve position, engine and station condition, fire explosion mixture, unauthorized entry of personnel, etc.

The paper is well illustrated and includes many useful flowsheets. M. F. M.

SAFETY PRECAUTIONS

269. Gas-freeing, ventilation, and tank drying. Anon. *Petrol. Times*, 24.10.58, **62** (1597), 870.—Equipment developed for high-speed ventilation of tankers is described. It consists essentially of a steam turbine coupled to a blower which provides an air flow through the main cargo piping system at rate of 8–20,000 cu. ft/min, an air preheater being installed at blower. Need for wind sails or blowers is eliminated. The system can be used for corrosion control for tank drying. An abridged specification is given. G. A. C.

ECONOMICS AND MARKETING

270. U.K. petroleum statistics 1957. Anon. *Inst. Petrol. Rev.*, 1958, **12** (142), 341.—Figures for 1955, 1956, and 1957 from Ministry of Power Statistical Digest of crude oil supplies, crude and product imports and exports, refinery throughput and output, and overseas crude production by British companies. E. M. I.

271. Functions of an economist in an oil company. S. B. Jurenev. *Proc. Amer. Petrol. Inst.*, 1957, **37** (6), 108–12.—The expanding and increasingly complex operations of the petroleum industry have brought about a demand for a new type of economist—the petroleum economist. More specifically, the position of a petroleum economist has been created by management in order to enhance the effectiveness of existing co-ordinating mechanisms within a company. This is because certain types of problems may not readily lend themselves to prompt and effective solution by committees composed entirely of operating personnel, or otherwise should not be approached from a pure departmental or regional viewpoint.

It is the primary function of the petroleum economist and his staff to approach such problems from an overall company viewpoint, giving due weight to general business and industry trends, and to render their recommendations promptly in a brief, objective, and truly analytical report. To achieve this, an economic unit must have strong support from top management, particularly in its first faltering steps. The manager not only must be given sufficient prestige and authority, but must also establish proper relationships with the heads of operating departments. If this is done, the petroleum economist and his staff can grow into an indispensable tool for top management. (Author's abstract.)

272. The emerging economic outlook for 1958. M. R. Gainsbrugh. *Proc. Amer. Petrol. Inst.*, 1958, **37** (6), 96–101.—It is becoming clearer and clearer that capital spending by private business will be declining in the months immediately ahead. Are we entering a period of readjustment which is different from the business recessions of 1948–49 and 1953–54? How long will the decline in capital investment continue?

In the two previous post-war recessions the basic readjustment began in the inventory sector, with some help from the post-Korean cutbacks in defence spending in the latter cycle. The current pattern seems to have begun in the investment sector. In the post-war record, there is no evidence that once a decline in capital spending sets in, it will last only one or two quarters and then reverse direction.

Sobering as the prospective decline in capital spending may be, there still remain elements of strength in the economy. To the extent that strength in other sectors of the economy can snub the capital-spending decline, holding it to reasonable proportions, the overall business decline could be moderate and short-lived. Yet business is now operating substantially below desired capacity-utilization rates. On the basis of past experience, any correction of this imbalance could not, on the face of it, take place in a matter of a few months.

(Author's abstract.)

273. Future growth of the world petroleum industry. K. E. Hill, H. D. Hammar, and J. G. Winger. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 105–17.—Various authoritative estimates indicate U.S. population may rise from 168 millions in 1956 to 197 millions by 1966. This growth, plus a rising standard of living, points to an even greater expansion of overall economic activity.

Detailed study of the energy requirements associated with the population and economic growth foreseen indicates an increase of 45% in the next decade. Petroleum is expected to supply *ca* half the overall energy needs. In doing so, demand for oil will grow at an average rate of 5% p.a. and reach a level of 14·3 million b.d. in 1966.

Being at a much earlier stage of development, oil demand in the free foreign areas seems likely to expand more rapidly than in the U.S.A. For the next decade it is believed that demand abroad will grow *ca* 7·7% p.a. and will be averaging 14·2 million b.d. in 1966. Combined demand for the free world will exhibit a growth of 6·2% p.a. and will total 28·5 million b.d. in 1966.

There is little doubt that crude oil reserves in the free world are ample in respect to anticipated demand growth. But these reserves are unevenly distributed relative to areas of greatest consumption. Because reserves are large relative to production, free foreign output is capable of expansion in most areas at a rate much faster than in the U.S.A. The Middle East, Venezuela, and Canada will contribute most to the additional production. But all areas of the world are expected to show gains as a result of the enormous growth in worldwide exploratory efforts. (Authors' abstract.)

274. Petroleum demand—past and future. A. J. McIntosh. *Proc. Amer. Petrol. Inst.*, 1957, **37** (6), 102–7.—Total U.S. demand for petroleum products will decrease 0·4% to 9,442,000 b.d. in 1958, with domestic demand increasing 2·6% to 9,143,000 b.d. and exports decreasing 47·1% to 299,000 b.d. Total free-world demand will increase 5·4% to 16,966,000 b.d. The breakdown of domestic demand (in thousands of b.d.) is: gasoline, 3950; middle distillates, 2085; residual fuel oil, 1523; other products, 1585. By 1967, total U.S. demand will reach 12,850,000 b.d. and free-world demand will reach 25,150,000 b.d. (Author's abstract.)

275. What's ahead for the domestic oil industry. D. L. Connelly. *Proc. Amer. Petrol. Inst.*, 1958, **37** (4), 35–7.—Consumption increase in the years ahead will be at least as

great as in the past decade, because of the growing population, expanded mechanization, and the many new uses being found for oil and gas. It has been estimated that domestic requirements in 1965 will be 1½ times greater than they are at present.

Increased demand will require greater crude oil production. To meet this demand, the industry is confronted with the necessity for expanding its exploration, drilling, and production operations, and with the substantial capital outlay necessary for increased facilities and sufficient producing ability.

Oil is becoming and, barring startling new geophysical or geological concepts, will continue to be increasingly difficult to find. This means greater dependence upon technological advancements—improved prospecting techniques, intensified application of all aspects of geological exploration, development of new and improvement of old recovery methods.

Future demands for petroleum products offer an extremely bright future for domestic producers, and they will continue to find and produce the oil required. They must, however, have the essential incentives—high enough price per brl and high enough allowables—in order to supply the huge quantity of petroleum that will be required. (Author's abstract.)

276. An American oilman looks ahead. A. L. Nickerson. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 28–32.—The difficulty, and consequently the cost, of finding large quantities of oil in the U.S.A. grow greater with every passing year. In order to find the increasingly large quantities of oil necessary to supply mankind's demand, and to provide it at costs competitive with other sources of energy, American oilmen are going to have to look abroad more and more.

There are, of course, new factors to be considered in making an investment abroad. The risks, the negotiations for mineral rights, the access to markets are often far different from those encountered in the U.S.A. On the other hand, there are more unexplored and untested areas which look geologically attractive outside the U.S.A. than inside it.

The subject of foreign oil invariably brings up the question of how much crude the U.S.A. should import, at the present time and in the years to come. The growth of demand for oil in the U.S.A. has been effected not only by imports, but by the great growth of natural gas, the revival of the coal industry, and the warming trend in the climate.

There is a serious question whether it is in the national interest indefinitely to produce half the world's oil in the U.S.A. from a fifth of the world's total reserves.

(Author's abstract.)

277. The Voluntary Oil Import Programme—a challenge. M. V. Carson, Jr. *Proc. Amer. Petrol. Inst.*, 1957, **37** (4), 16–19.—The petroleum industry in America is a dramatic example of the vitality and resourcefulness of the private enterprise system. In those nations which have nationalized their petroleum industries, government regulation has resulted in continuing financial, technical, and management difficulties. On the other hand, development has proceeded with unprecedented success where private initiative has been allowed to flourish.

In view of this history, the federal government would like to depend upon the industry to regulate its volume of imports on a voluntary basis. But only so long as the voluntary method is successful does the petroleum industry have any strong measure of insurance against governmental controls—either by administrative action under the Trade Agreements Act or by future legislative decree. (Author's abstract.)

MISCELLANEOUS

278. Photochemical formation of air contaminants from automobile exhaust vapours. Effects of different motor fuels. P. P. Moder *et al.* *Industr. Engng Chem.*, 1958, **50** (8), 1173–4.—Because automobile exhaust is a major factor in development of the type of smog that accumulates periodically over the Los Angeles basin, there is interest in reducing its contribution by modification of the type of fuel consumed.

Under controlled experimental conditions maintained during comparison of two fuel blends, the composition of exhaust gases and their capabilities for participation in photochemical reactions resulting in smog were shown to depend on the make-up of the charging fuel—specifically, amounts and types of olefins in the fuel blend.

The exhaust products of two fuels, consumed under the same conditions and in the same engine, differed significantly in their effect on photochemical formation of eye irritants, aldehydes, organic peroxides, and ozone. M. F. M.

279. New metals in oil industry. Pt II. W. L. H. Hooper. *Petroleum, Lond.*, 1958, **11** (9), 313.—Tantalum (Ta) and Niobium (Nb) are scarce metals both as regards total amounts present in the earth's crust and also from the point of view of occurrence in concentrated deposits. The nuclear programmes demanding and utilizing materials of low neutron capture cross-section have brought such metals to the fore, and it is possible that they might eventually be produced in greater quantities than titanium is at present.

The physical and mechanical properties of these two metals are described, and their corrosion resistance quality is discussed. As a material for the construction of acid-resisting equipment in the chemical industry tantalum is unsurpassed, and because of this high resistance it can be used in very thin gauges (0·012–0·020-inch thick). Shielded arc methods can be used for welding these metals, but welding is not, generally, an easy or a simple job. M. F. M.

280. Applied hydrocarbon thermodynamics. Pt 6. Improved Mollier charts for hydrocarbons. W. C. Edmister. *Petrol. Refin.*, 1958, **37** (6), 195–208.—Mollier (enthalpy–entropy) charts are used in making calculations for refrigeration and expansion engines. Impurities having a higher or lower b.p. than the principal component alter the properties in such a way that a pure component enthalpy–entropy chart does not apply correctly. There is not much need then for a Mollier chart for hydrocarbons not used in refrigeration cycles. The author presents enthalpy–pressure charts for eight light hydrocarbons, methane, ethylene, ethane, propylene, propane, *iso*butane, *n*-butane, and *n*-pentane. Details of the procedure for the preparation of the charts are given, showing the development from the basic data of a Mollier chart.

J. R. T.

281. French petroleum. (In French.) J. M. Louvel. *Rev. Petrolière*, Dec. 1956, (986), 37–40.—The international petroleum position is reviewed, with particular reference to France. Energy consumption in coal tons per inhabitant—a measure of a country's development—in the U.S.A. is 8, in Europe 2·8, in France 2·5. In 1900 the world consumption of all forms of energy in coal tons was 720 millions, in 1955 it was 3·5 milliards. In 1900 coal accounted for 97%, in 1955 approx 50%, petroleum intervened with 32%. Producer countries, means for supplying consumer countries, the effect on consumers of prolonged closing of the Suez Canal, and total suppression of Middle East supplies are discussed. Other sources of petroleum are a national necessity. France's interests in the Middle East assured her 10,500,000 tons of

petroleum in 1955. The imports, 24 million tons, require a large tanker fleet. Noteworthy increase in refinery capacity is discussed. The search for oil and results attained in Metropolitan France and Africa are described. R. T.

282. European petroleum industry. Anon. *Petroleum, Lond.*, 1958, **11** (8), 273-6.—W. Europe has become one of the biggest consumers of oil products with negligible resources of indigenous crude. The production figures for 1957 among the countries of W. Europe were: Austria 3 million tons; Germany 4 million tons; Holland, France, and Italy approx 1·5 million tons each. In E. Europe Rumania, with 11·5 million tons, and the U.S.S.R., with 98 million tons are the biggest producers. W. Europe has a refining capacity and rate of consumption more than 11 times its total production. E. Europe, within its political boundaries, is self-sufficient in oil.

The refining capacities in W. Europe at the end of 1957 (in million tons p.a.) were as follows: U.K. 30·0, France 29·4, Italy 26·0, Germany 15·8, Holland 13·0, Belgium 7·0, others 12·7. M. F. M.

BOOK REVIEWS

The Future Supply of Oil and Gas. Bruce C. Netschert. Baltimore: Johns Hopkins University Press; London: Oxford University Press, 1958. Pp. 126. 24*s*.

This study is part of a larger investigation of the energy position of the U.S.A. through 1975, which is being undertaken as part of the Energy and Minerals Programme of Resources for the Future, and which commendably has been made available prior to the completion of the larger project.

It is a critical study of current technical opinion, and is not intended as a technical contribution containing original geologic and engineering data.

It is emphasized at the outset that the study is concerned with domestic availability (productive capacity) that could be forthcoming in the arbitrarily chosen but convenient year 1975, with no appreciable increase in constant dollar cost.

The three factors that determine such future possible productive capacity are the natural stocks of these hydrocarbons, the technology of finding and producing them, and the course of production between now and 1975. The last factor is summarily dealt with by the assumption that the growth in output between now and 1975 will be constant by and large, whatever the possible productive capacity in the terminal year may be.

The concept of " resources " as the basis of availability is introduced. This is some quantity of natural stocks (in this study the quantity that could be exploited at about present costs with foreseeable technological advancement) greater than reserves as normally defined in terms of rather short-term economic feasibility of extraction, and less than " resource base," which is conceived to include the sum total of the crude oil, natural gas, and natural gas liquids present in the earth's crust within a geographic area. These three hydrocarbon raw materials are dealt with successively.

The author tabulates and reviews estimates of " ultimate crude oil reserves " that have been published in the last ten years. Using an accepted current recovery factor of one-third of original oil in place in known reservoirs, the author derives equivalent " resource base " figures, concluding that the total crude oil potentially available for future recovery in the U.S.A. can be inferred from expert opinion to be of the order of 500 billion barrels. Half of this had yet to be discovered as of 1 January 1956.

To aid further in estimating the future availability of crude oil from domestic sources, the author then examines published authoritative opinion on future productive capacity. These estimates can be divided into two groups: those that carry an expectation of a production peak in the period through 1975, and those that do not, depending on the assumption that resources either will or will not limit growth in production. A critical discussion is made of " the decline curve " approach used by most of the estimators, a major shortcoming of which is held to be its exclusion of technological change: whereas in the author's view due cognizance should be taken of improvements to be expected in technology.

As regards discovery technology, the value of statistical evidence in discussions of future discovery prospects is questioned. After considering the large portion of the U.S.A. which is relatively unexplored, and that not much is known about the occurrence of oil in depth, or the oil potential in unorthodox sources, there seems no reason to believe that discovery will be hampered by approach to the limits of current technology, at least in the period through 1975. Furthermore, the reasonable expectation is that future discovery technology will contribute to the finding of oil where present technology is unable to do so.

The author adopts from those estimates by the experts that seem to be the more representative of these conclusions, a quantitative figure of primary domestic crude oil availability in 1975 of 4 billion barrels.

As regards drilling and production technology, developments in drilling practices and techniques are reviewed, and views on secondary recovery are discussed in relation to possible higher recovery rates in the future. It is concluded that the indications point to the imminent occurrence of a sudden large jump in the recovery factor, and that a recovery factor of two-thirds as the average for the U.S.A. within the next 15 years or so would be well within the possibilities being opened up. In the author's judgment a figure of 2 billion barrels indicates the general magnitude of secondary availability in 1975.

Thus, the indicated total domestic availability of crude oil in the U.S.A. in 1975 at no appreciable increase in constant dollar costs is of the order of 6 billion barrels (16½ million barrels per day).

The future of natural gas is next dealt with; an even more difficult subject because of the mode of occurrence of natural gas as associated and non-associated gas. Published estimates of natural gas reserves are reviewed, most of which, because of incomplete records of past production, are concerned with current proved reserves plus anticipated future discoveries of such reserves. It is pointed out that each of the estimates involves the basic assumption of a total future crude oil supply, and of a gas–oil ratio applied to the crude oil figure.

A review of some dozen estimates of future natural gas production brings out the wide ranges in the estimates of the year of peak production (from 1960 to after 1980), of peak output where specified in the period through 1975 (12 trillion to 16 trillion cu. ft.), and of output in 1975 (from 11 to 22·5 trillion cu. ft.).

So far as concerns the role of technology in the future, production aspects are relatively unimportant, and for the most part the discovery of natural gas is closely linked with the search for oil. As the crucial element in estimating the future total natural gas supply remains the choice of an appropriate gas–oil ratio, published data are examined with this end in view. Various gas–oil ratio combinations were considered, based on API and AGA reserve reports over

the last decade. Each showed the tendency of the gas–oil ratio to increase as time goes on. For the year 1956 the ratios varied from a low of about 2500 cu. ft. per barrel for proved reserves of associated gas to proved reserves of oil, through 7800 for current proved reserves, to nearly 12,000 cu. ft. per barrel for discoveries of proved reserves in new fields and new pools (comparable figures for 1957 are 2522, 8100, and 21,600). In the end the author makes the arbitrary choice of 7000 cu. ft. per barrel as being a reasonable figure.

Using this figure in combination with his resource base figure of crude oil, there is an indicated quantity of natural gas potentially available for future recovery of the order of 1·2 quadrillion cu. ft.

As to the availability in 1975, the author takes the highest of the published estimates, namely, that of the AGA of 22·5 billion cu. ft. and examines the implications in the light of his choice of crude oil primary and secondary availabilities. It is concluded that the figures are not inconsistent, but that the AGA figure must be taken on the basis of present knowledge as the limit of domestic natural gas availability in 1975.

The point is made that without a significant decline in cost, synthetic gas is unlikely to provide more than minor local competition by 1975.

The book concludes with a section dealing in a similar systematic manner with natural gas liquids, but with fewer published estimates for guidance. Using a published figure of 60 barrels per million cu. ft. as the ratio of occurrence in nature, and the total future gas supply estimate of 1·2 quadrillion cu. ft., a resource base of 72 billion barrels is arrived at: and using the estimate of 22·5 trillion cu. ft. for availability of natural gas in 1975, and a figure (limited by current technology and costs) of 50 barrels per million cu. ft., a domestic availability in 1975 of the order of 1 billion barrels is arrived at.

The author's expectations place him among the optimistic analysts of future domestic oil and gas supply in the U.S.A.

H. H. D. A. L.

Desert Enterprise: the Middle East Oil Industry in its Local Environment. David H. Finnie. Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1958. Pp. x + 224. 40*s*.

Mr Finnie was not, before he wrote this book, a professional oil man. (He has, one understands, become one since, by joining Aramco.) How far is this fact reflected in his work? And how far does it detract from its value?

The book, which covers only the main Persian Gulf producing countries, and not the less fortunate lands in the Levant and Africa, has little to say of actual operations, to which only a few summarizing pages are devoted, and nothing of technical matters or achievement, or the course of development, or the particular atmosphere of oilfields and installations which means so much to the resident or ex-resident executive or worker. But these matters, not inadequately covered by other books (including some a lot less readable than Mr Finnie's), are not his subject. He sets out, on the other hand, as soon as he has cleared the ground by a few notes on the companies concerned, and their concessions, and the local governments, to give us something of the impact of the industry on its own workers; of the diverse treatment of these, their privileges and amenities; of public reactions; of recruitment, training, turnover of labour, strikes, discipline, local contacts, housing; of aid given in a score of ways by the companies to the local governments, central and regional, and the range, not easy to simplify into a short account, of company–government and company–public relations; and of the companies' efforts, so hard to direct wisely and effectively, to give a fair picture of themselves to the dwellers, and the governing authorities, of the territory.

The writer has brought to his task, which is published as one of a Harvard series of "Middle Eastern Studies" and carries a foreword by Professor Gibb, an acquaintance with the more accessible and recent books on the subject, with the periodical oil press, with company reports, and with a few "background" works, the whole indicating an industrious and prudent use of the written sources. He also paid a visit of some duration to the scene of action, saw much with his own eyes, and talked to knowledgeable people in each country and company. And he views all that he saw, heard, and has read from the viewpoint natural to a trained, humane, and sensible mind. This has enabled him to produce a work not, indeed, of outstanding importance or originality, but one not unworthy of the Harvard imprint, and likely to interest and instruct a considerable number of readers. Mr Finnie seems to have no more access to company papers (or secrets) than the man in the street, and he writes confessedly as an outside observer; but he is temperate in judgment, well documented, and gracefully impartial as between the nationalities of the companies he reviews. The mainly bibliographical "notes" are careful, the index good, and the photographs pleasant. S. H. L.

Air Pollution. Based on papers given at a Conference held at the University of Sheffield, Sept. 1956. Ed. M. W. Thring. London: Butterworths Scientific Publications, 1957. Pp. x + 248. 42*s*.

The report of the 1954 Air Pollution Committee was purposely written so that the problem of air sanitation could be understood and the need for action endorsed by the public. There is, however, a gap between our technical knowledge of the problem and the application of the methods for the elimination of air pollution from flue gases. This book, which comprises a series of chapters by a number of experts who previously lectured on the subject of air pollution at a course arranged by the University of Sheffield, makes a contribution towards bridging this gap. Aspects covered include the characteristics of solid and gaseous pollutants, the measurement of air pollution and of smoke in chimneys, the consequence of air pollution in regard to health, buildings, and metalwork, the dispersion of discharged gases, including geographical factors, the elimination of pollution from domestic heating appliances and from vehicle exhaust, industrial boilers, the iron and steel industry, refractories, ceramics, and cement manufacture. The choice of gas cleaning plant and air pollution legislation are also discussed. All of the chapters are adequately illustrated with photographs, figures, sketches, and tabulated data.

One fact that emerges quite clearly is that the most damaging and widespread constituents of air pollution are dark smoke and sulphur dioxide. While the former is being dealt with under the Clean Air Act, little is being done to reduce sulphur dioxide emission. The seriousness of air pollution is rightly stressed, but at present emphasis appears to be placed on the dispersal of pollutants.

It is a tribute to the editor that the many aspects, each covered by a separate author, are presented in a form suitable for continuous reading. As might be expected, however, in a book of limited size covering so many aspects, the technical level varies considerably from chapter to chapter.

The chapter on the geographical factors of flue gas dispersion reaches a high technical plane and is useful in that information on this aspect has not been highlighted in the past.

This book should be regarded as a general practical reference book which provides a starting point for research workers, local authorities, medical workers, and technicians in the manufacturing industries about to tackle air pollution problems.

E. L. H.

The Petroleum Chemicals Industry. Second Edition. R. F. Goldstein. London: E. & F. N. Spon, 1958. Pp. xv + 458. 95*s*.

It is now nearly ten years since the first edition of this book appeared. In the intervening time the petroleum chemical industry has expanded very considerably, particularly in Europe, where as a result of the second world war, it was slow in developing. Both the quantity and the range of chemicals produced has increased enormously. So it is perhaps a little surprising that during this time so few books have appeared on the subject. Of those which have, Goldstein probably remains the best-known.

The second edition is a worthy successor to the first. The author has written for a wide range of readers from the consultant to the student and has succeeded in producing an eminently readable account of the subject.

The writer of a monograph in this particular field finds himself in some difficulty. Unlike the petroleum industry, which discusses most of its processes openly, the petroleum chemical industry does not, in this following the traditions of its parent, the chemical industry. As a result, much of the information available is based upon the patent literature, which is at times notoriously misleading. The present author, through his long association with the production of chemicals from petroleum, is, however, in a better position than most to select his data critically.

A further difficulty is concerned with the exact meaning of the term "petroleum chemicals." This could well include a large proportion of the compounds described in Beilstein and could include materials formerly produced by several industries, *i.e.* coal tar, oils and fats, and fermentation, to quote a few. Even if we accept a petroleum chemical as "one which can most economically be produced from petroleum," it must be appreciated that this definition is influenced by environment and the availability of a cheap supply of petroleum oil or gas. Butadiene, for example, is usually regarded as a petroleum chemical, produced by dehydrogenation of butane, yet it is obtained in some parts of the world, where no butane is available, from fermentation ethanol. Furthermore, many chemicals considered as petroleum chemicals are in fact derived from mixed sources, for example ethylbenzene, from oil-derived ethylene and coal-tar benzene. The inclusion of all materials which may potentially be derived from oil as petroleum chemicals could give those not versed in the subject a somewhat erroneous impression. Certainly, in the present book, a very wide range of chemical derivatives is included, some of which, while being potential petroleum chemicals, have probably never been produced commercially from oil or natural gas. Admittedly to-day a very large number of materials is being produced from oil, but possibly not so wide as the impression created. This is borne out by the fact that some compounds mentioned in the earlier edition do not appear in this, since they have not developed as expected.

In the second edition, two new chapters have been added. The first is concerned with the history of the industry and the second provides statistical and economic data. The earlier historical period, covering 1920–40, does not entirely agree with the facts. Long before 1920 chemists had endeavoured, with little success, to convert the promising new raw material, oil, into useful chemicals. Apart from a few soaps derived from waxes by oxidation and useful on account of the oil-solubility of their metal salts as driers, etc., no important industrial chemicals appear to have been produced. In the latter stages of the first world war nitroaromatics were obtained on a small scale by nitration of Borneo distillates, and these may well be regarded as the first petroleum chemicals. Separation of cracking gases was first achieved by selective adsorption, since the olefin content of the gases was low. Fractional distillation under pressure followed later, and can be associated with Podbielniak's development of the low-temperature fractionating column and high-temperature low-pressure cracking (Gyro process).

Although omitted from the first edition, some consideration has now been given to the inorganic petroleum chemicals, *e.g.* ammonia, sulphur, and so on. These constitute a very large proportion of the total tonnage of petroleum chemicals produced. The bulk of the helium produced from natural gases comes within the definition of a petroleum chemical, as well as naphthenic acids and cresols recovered from refining operations. Little mention is made of these.

Some of the facts given concerning the composition of petroleum oils are somewhat out of date. The author is not so sure of his ground when discussing his basic raw material, petroleum. The table (p. 19) giving the composition of a "de-pentanized petrol" omits *cyclo*pentane, presumably because it is a C_5 hydrocarbon, and as such might be expected to be excluded from a C_5-free product. A petroleum residue is referred to as containing "pitch" instead of bitumen (p. 22). The table of hydrocarbons identified by Rossini in a Ponca City "petrol" mentions about a third of those actually identified, and these are somewhat arbitrarily chosen; the boiling points of *cis*- and *trans*-1,3-dimethyl*cyclo*pentane are reversed in the table of boiling points given in the appendix (p. 408). These are, however, minor points and do not detract from the usefulness of the book as a whole.

The second edition is as well produced as the first. The publishers have been wise in using folding pages for diagrams, which make them far easier to understand, rather than to attempt to compress them on to a normal page.

S. F. B.

Methods of Analysis for Petrochemicals. Ed. R. Littmann. New York: Chemical Publishing Co. Inc., 1958. Pp. 384. $12.

The authors state that the object of this work is to provide the chemical industry with dependable tentative standard procedures for the testing of primary and secondary products derived from petroleum. The title may be slightly misleading, since the scope of the methods does not include those for the large range of organic chemicals and manufactured materials derived from these primary and secondary products. The latter comprise olefins, aromatics, and certain ketones and alcohols.

Of the 364 pages of text, 95 pages are devoted to full reprints of ASTM methods, mainly those for the testing of petroleum products, and 45 pages to methods based on ASTM methods but which have been rewritten or slightly modified. Most of the reprinted ASTM methods have introductory notes, giving in many cases useful advice to the analyst on the applications of the method. These notes occupy 15 pages.

The remainder of the volume consists of an assortment of methods, physical and chemical, which are recommended by the Enjay Company for the determination of the specification limits controlling the quality of the products sold by them.

It is surprising to find that the section dealing with kinematic viscosity ignores the detailed account of this subject given in ASTM D445–53T, while 12½ pages are devoted to the procedures and apparatus recommended by the Enjay Company, with notes that the apparatus described can be obtained from them and the thermometers from Standard Inspection Supply (Enjay Company).

It is noted that the only test given for potential gum in gasoline is one using a copper dish for the evaporation.

There is a useful section (16 pages) on the application of the Karl Fischer method to the determination of water in

liquid and gaseous petroleum products (apparatus obtainable from the Enjay Company). Two types of the reagent are employed; one of them, from which methanol is omitted, is for use when aldehydes and ketones are present in the sample under test. The diagrams of apparatus on pp. 204 and 212 have been transposed.

Directions for the determination by specific gravity of the alcohol content of aqueous alcohol occupy nine pages, including five pages of tables giving the specific gravities of ethanol and methanol aqueous solutions. There is a section on the application of infra-red spectrometry to the analysis of *iso*butylene and one on the application of ultra-violet spectrometry to the determination of acetone in *iso*propyl alcohol. Other sections deal with the determination of certain inhibitors, *e.g.* amino type compounds, tertiary butyl catechol, and α-naphthol, determination of unsaturated groups, conjugated diolefin content of *iso*prene, ester and carboxyl groups, peroxides, etc., and methods for the assessment of colour of petroleum products.

Since most laboratories dealing with this range of products are likely to be familiar with and to have ready access to ASTM methods, it seems that the reprinting in full of so many of these methods does not serve any useful purpose and has merely added to the cost of the publication.

The book as a whole is well produced, the printing is very good, and the instructions on procedures clearly given. In the methods, other than those of ASTM, the precision figures are generally omitted. M. T.

Taschenbuch für die Wachsindustrie. 4th Edition. Ed. C. Lüdecke and L. Ivanovszky. Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1958. Pp. 718. DM 48.

It is some years since the third edition of Dr Lüdecke's "Taschenbuch für die Wachsindustrie" appeared, and in view of the advance in the technology of waxes since then, the appearance of the present edition, prepared with the collaboration of Dr Ivanovszky, is very welcome.

The book covers all types of waxes (plant, animal, mineral, and synthetic) their properties, examination, and application, and contains a wealth of information on these subjects. The classification of waxes is dealt with in the introductory section, and the subsequent treatment follows this pattern. The numerous tables contain much valuable data, and the references to special waxes and trade names are also useful. Petroleum waxes receive a fair share of attention. Section VI, which deals with additives and blending agents for waxes, such as steam, plasticizers, silicones, and emulsifying agents, collects much useful information on such subjects.

It must be appreciated that the book is written essentially for the German industry and that therefore certain aspects are treated quite fully, while others receive much less attention than the British reader might expect. This applies particularly to Part VII, which deals with the applications of waxes. In the 100 pages of this section, 73 are devoted to cleaning materials, while shoe-creams alone occupy 40 pages. The waxed wrappings industry, which is of considerable importance in the U.K. and other countries, is only briefly referred to. The candle industry receives 11 pages of text in this section.

The indexes are divided into a number of sections. These cover the tables in the text; a number of general tables following the text in Part IX; indexes for tables 1–31 and for tables 35–55; subject index for Parts III, IV, and V; author indexes; and a general subject index. This system is rather difficult to use. For example, the entry "Papier, gewachstes, imprägniertes, pp. 148, 156" is included in the index to Parts III, IV, and V, but not in the collective subject index.

Similarly, the collective index gives for "Verpackungsindustrie" the page references 148, 313, 316, 413, 445, and 516, while the index to Parts III, IV, and V gives only 148, 149, 313, and 316. A search through the various indexes is therefore necessary to locate all the references to a particular subject. The ease of use of this book, which is essentially one of reference, could be improved by the substitution of a really comprehensive index for the partial indexes.

The book does, however, contain a great deal of information of value to anyone concerned with waxes of all types, and should find a place on the shelves of all technical libraries and specialists. E. B. E.

Knocking Characteristics of Pure Hydrocarbons. ASTM Special Publication No. 225. Philadelphia: American Society for Testing Materials, 1958. Pp. 96. $6.00 (members $4.80).

For nearly 20 years part of the work of API Project 45 on the "Synthesis and Properties of Hydrocarbons of Low Molecular Weight" has been directed to the measurement of the anti-knock values of hydrocarbons, mainly in the gasoline boiling range. In order to make the data obtained more readily available, arrangements have been made for its publication in book form by the ASTM.

The volume now produced lists the anti-knock behaviour of nearly 350 hydrocarbons, together with that of about 25 non-hydrocarbon compounds, *e.g.* alcohols, ethers, ketones, and some nitrogen compounds. Results have been obtained by the ASTM Research and Motor Methods, on the G.M. Variable Compression Engine and on the 17·6 Supercharged Engine. They are given in terms of octane number, blending octane number, and critical compression ratio, and include data on both straight hydrocarbons and on leaded blends. In the case of the G.M. Engines, combination of two engine speeds (600 and 2000 rev/min) and two jacket temperatures (212° and 350° F) were used and for the 17·6 Supercharged Engine results are given for air temperatures of 125° and 225° F. Explanatory notes are included, together with sections on the correlation of knocking characteristics of pure hydrocarbons with molecular structure, on the nomenclature of the compounds examined, and on the physical properties of the hydrocarbons. The data embody the results of many years careful work on the knock characteristics of compounds of a purity of 98 mole per cent or better and, allowing for changes in knock measurement technique in the period involved, the compilation is a most valuable work of reference. E. B. E.

Tables of Interatomic Distances and Configurations in Molecules and Ions. London: The Chemical Society, 1958. Special Publication No. 11.

The introduction to this book occupies 18 pages and deals with scope, coverage, comprehensiveness, organization, presentation of material and error.

The compilation itself contains all the useful data published up to 31 Dec. 1955, and consists of:

(1) A table (19 pages) of selected bond lengths.

(2) The main table, section A (101 pages), which covers inorganic compounds arranged according to the Mendeléeff classification. Section B (158 pages) deals with organic (carbon containing) compounds.

(3) Reference tables (69 pages) which are keyed to the entries in the main table by symbols which give the year, journal, and method of measurement. With each reference is a list of the compounds examined.

The book is completed by 9 pages of a classified name index of organic compounds and will be of undoubted value to chemists and physicists, particularly those engaged in spectroscopy and structural identification. W. H. T.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren " Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the " Library Catalogue " published by the Institute.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

283. Devonian system in Williston basin and Central Montana. C. A. Sandberg and C. R. Hammond. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2293–334.—Knowledge of Devonian stratigraphy in the S. part of the Williston basin and adjacent areas has increased greatly since extensive deep drilling began in 1951. In recent years many formation names have been borrowed from the Alberta basin, the Canadian part of the Williston basin, and the N. Rocky Mountains of W. Montana and applied with varying degrees of success but little uniformity to the buried Devonian rocks of Central Montana and the U.S. part of the Williston basin. This paper summarizes the stratigraphy and geologic history of the Devonian system and proposes a uniform subsurface nomenclature for Devonian rocks in N. Dakota, S. Dakota, E. and Central Montana E. of the 111° meridian, and the adjacent part of Wyoming. E. N. T.

284. Niobrara–Pierre boundary along Front Range, Colorado. L. W. LeRoy and N. C. Shieltz. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2444–64.—The Sharon Springs member of the Pierre formation and the Smoky Hill member of the Niobrara formation, both assigned to the Upper Cretaceous, are separated by an unconformity in at least five of the six sections studied along the Front Range of Colorado. Onlap of the Sharon Springs and possibly truncation of the Smoky Hill are involved in this unconformity. The basal Sharon Springs shales are believed to have accumulated under stagnant, acid bottom marine conditions, whereas the Smoky Hill deposits were laid down in a well oxygenated marine environment. The foraminiferal fauna of the Smoky Hill is represented by abundant calcareous, pelagic forms as contrasted to a limited arenaceous fauna of the Sharon Springs. X-ray diffraction analyses of the Sharon Springs and Smoky Hill bentonitic-type clays show a prevalence of montmorillonite in the Sharon Springs, and kaolinite in the Smoky Hill.

192 samples from six surface sections constitute the basis of this investigation. E. N. T.

285. Middle Ordovician stratigraphy in Eastern Nevada and Western Utah. G. W. Webb. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2335–77.—Stratigraphy of Middle Ordovician quartz arenites and related rocks is traced from Central Nevada to Central Utah, and correlations with N. Utah rocks are suggested. Following accumulation of thick, fossiliferous Pogonip carbonate rocks, miogeosynclinal regressive Kanosh argillites and the Watson Ranch tongue of the Swan Peak quartzite were deposited in W.-Central Utah and along the SW. flank of the Tooele arch, a Middle Ordivician emergent element W. of Provo, synchronous with Chazyan Swan Peak argillite and quartzite deposition in N. Utah. After subsequent accumulation of the Crystal Peak dolomite, the basal regressive phase of the Eureka quartzite was spread westward from Central Utah, culminating in the fossiliferous undaform edge Copenhagen formation in Central Nevada. E. N. T.

286. Cretaceous and Tertiary orogeny in Jackson Mountains, Humboldt County, Nevada. R. Willden. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2378–98.—A formation of Early Cretaceous age composed of locally derived clastic rocks, including pebble to boulder conglomerate, siltstone, coarse graywacke, and finely crystalline limestone is exposed at several places in the Central and N. part of the Jackson Mountains, Humboldt County, Nevada. This formation was folded and at two places probably completely eroded before deposition of the next younger unit—a pebble conglomerate composed of exotic pebbles of chert and quartzite derived from rocks of early Palæozoic age. This younger pebble conglomerate may be of Late Cretaceous or early Tertiary age and may be equivalent to rocks of similar stratigraphic position and lithologic character exposed over a considerable area of E. Nevada and W. Utah. Both of these coarse clastic formations have been overridden by a thrust sheet of Permian or older volcanic rocks. E. N. T.

287. Stratigraphy of Northwestern Wind River basin and range, Dubois area, Fremont County, Wyoming. C. C. Reeves, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2399–423.—The NW. part of the Wind River basin and range is in the NW. tip of Fremont County, Wyoming, and within sight of the Absaroka Mountain escarpment.

From the Precambrian core of the range to the basin area surrounding Dubois, a nearly complete stratigraphic column is present; the best exposures can be found in the many canyons cut in the dip slopes.

The Precambrian to Upper Jurassic stratigraphy was studied along Warm Spring Creek, the Upper Jurassic to Cretaceous in the Little Horse Creek area, and the Lower Cenozoic around Brooks Lake. E. N. T.

288. Stratigraphic relation of latest Cretaceous rocks in parts of Powder River, Wind River, and Big Horn basins, Wyoming. E. I. Rich. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2424–43.—The recent discovery of oil in the Mesaverde formation in the Powder River basin, Wyoming, has placed new economic emphasis on the intertonguing relation of the Mesaverde and adjacent formations in Central Wyoming. Surface studies in the SE. part of the Wind River basin and subsurface studies along the SW. margin of the Powder River basin and S. part of the Big Horn basin have outlined several regressive and transgressive pinch-outs within the Mesaverde and adjacent formations that may have possibilities as oil and gas traps.

The basal unit of the Mesaverde formation, the Parkman sandstone member, reflects a widespread regression of the Late Cretaceous sea. Minor oscillations of the shoreline during this regression produced interfingering of offshore and littoral type sediments in the Cody–Mesaverde contact zone. The marine part of the unnamed middle member of the Mesaverde formation, which appears to be a tongue of the Pierre shale, represents a fairly widespread re-advance of the Late Cretaceous sea. E. N. T.

289. Twin River formation (redefinition), Northern Olympic Peninsula, Washington. R. D. Brown, Jr and H. D. Gower. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2492–512.—The Twin River formation of Arnold and Hannibal is redefined to include a mappable sequence of predominantly argillaceous, sedimentary rocks that are exposed in the N. Olympic peninsula, Washington. These rocks are typically exposed on Deep Creek, but well-exposed sections of the formation are also present on the Lyre River and along the Strait of Juan de Fuca between the mouth of the East Twin River and the mouth of Murdock Creek. The Twin River formation overlies the Lyre formation and is overlain conformably by the Clallam formation as used by Weaver. In the S. limb of the Clallam syncline, where it is best exposed, the Twin River formation has max thickness of 17,500 ft.

Three mappable units are recognized in the formation: a lower member consisting of thin-bedded sandstone and siltstone; a middle member of massive siltstone that grades westward into bedded siltstone and sandstone; and an upper member that is composed chiefly of massive mudstone. E. N. T.

290. Maritimes offer new challenge. W. S. Shaw. *Oil Gas J.*, 18.8.58, **56** (33), 253.—Exploration by 11 operators is in progress in an area of *ca* 18,000 sq. miles in the Maritime Provinces, Canada. Commercial production was first established in 1909 at Stoney Creek. Mississippian, Pennsylvanian, and Permian sediments accumulated in several basins, the estimated thickness in the largest of which (the Cumberland Basin) being at least 25,000 ft. The present producing formations are fluviatile and lacustrine sediments of the Mississippian Horton group, and these and the marine carbonate rocks and evaporites of the Mississippian Windsor group offer the best oil and gas prospects. Structures of interest include broad open folds plunging from the margins into the basins; tight thrusted folds, particularly in SE. New Brunswick; and salt anticlines in N. Nova Scotia and W. Cape Breton Island. There are prospects of stratigraphic traps also. J. C. M. T.

291. Savanna Creek gas field, Alberta. J. C. Scott, W. J. Hennessey, and R. S. Lamon. *Canad. Min. metall. Bull.* 1958, **51** (553), 270–8.—Savanna Creek gas field in Alberta, 25 miles SW. of Turner Valley, is within the Rocky Mountains. Plateau Mountain, the dominating feature, is a broad elongated dome eroding in Palæozoic sediments, 9 × 3 miles in area and 8210 ft high. It is estimated that 14,000 ft of strata are involved in the Savanna Creek structure, in beds ranging in age from Upper Cretaceous to Upper Devonian. Large gas reserves have been discovered in the conglomerate and sandstone reservoirs of the Cretaceous. Remaining reserves have been found mainly in the limestone and dolomite reservoirs of Mississippian and Devonian. Drilling was stimulated by discovery of large gas reserves in Savanna Creek and extended well into the mountains, in face of unusual problems. The whole area is covered by faulting and folding, and local or regional wedge-outs exist. Savanna Creek 4 is currently drilling to explore for production in the potential fault-trap where porous beds of Livingstone formation are faulted against Fernie and Kootenay shales. Indications of gas zones occur in the Rundle slice encountered in No. 3A. Stratigraphy of the region is discussed with lit refs. Drilling is concerned with the search for stratigraphic traps, some associated with anticlines. A generalized columnar section illustrates the stratigraphic sequence to be found at the surface and cur-

rently known at depth. The main structural features of the Savanna Creek map-area are the Livingstone River syncline and the Plateau Mountain anticline; the area is illustrated with a descriptive legend. A critical discussion of the mechanics of faulting and folding is presented. R. T.

292. Newest major oil province. Anon. *Oil Gas J.*, 18.8.58, **56** (33), 169–76.—Three fields (Swan Hills, Virginia Hills, and Kaybob) are currently being developed in the inaccessible area S. of Lesser Slave Lake, N. Central Alberta, where oil and gas were first discovered in 1957. There are *ca* 9000 ft of sediments, ranging from Cambrian to late Tertiary age. Production is at present obtained from reefs in the Beaverhill Lake limestone of Devonian age, but indications of petroleum also occur in various members of the Cambrian, Silurian, Mississippian, and Cretaceous. The regional structure is a simple monocline dipping gently SW. The Devonian reefs do not appear to cause any compaction structures in overlying strata, but irregularities in the post-Palæozoic erosion surface are reflected by some Cretaceous structures. Net pay thickness varies from 11 to 143 ft; oil gravity from 38° to 41° API; drilling depths *ca* 8000–9000 ft. Reserves are not yet evaluated. Fields have been located by reflection seismograph.
J. C. M. T

293. Wildcatters' delight. C. W. Hunt. *Oil Gas J.*, 18.8.58, **56** (33), 136–40.—The structure of the Queen Charlotte Islands, British Columbia, is characterized by strike-slip and normal faulting, believed to be the surface expression of deep-seated overthrusting from the NE. Extrusive and minor intrusive igneous rocks predominate in the Jurassic and the Tertiary, but there are at least 6000 ft of sandstones and shales in the Upper Cretaceous, and 3800 ft of shales, limestones, sandstones, and tuffs in the Upper Triassic and Lower Jurassic. There are petroleum indications at the outcrops of all these sedimentary formations. The structural history of the islands suggests the possibility of a thick series of late Cretaceous and Late and Middle Tertiary marine clastics in the subsurface of NE. Graham Island.
J. C. M. T.

294. Northeastern British Columbia—giant of the future. G. L. Gray. *Oil Gas J.*, 18.8.58, **56** (33), 128–35.—The main geological provinces of NE. British Columbia are the Rocky Mountains, the foothills, and a N. extension of the Alberta basin. The last-named holds the thickest section of sediments known in W. Canada, with representatives of all systems from Devonian to Cretaceous. Principal structures are a series of folds parallel to the foothills produced essentially by the Laramide orogeny. Post-Devonian sediments thin eastwards, favouring stratigraphic traps. Areas of important gas accumulations are Fort St John, Buick Creek, Blueberry-Highway, Kobes, and Pouce Coupe; there is also oil at Boundary Lake. Out of 232 exploratory wells drilled 104 have been successful. J. C. M. T.

295. Abu Dhabi's discovery. Anon. *Oil Gas J.*, 15.9.58, **56** (37), 120.—Umm Shaif 1, 20 miles off Das island off the Trucial Coast of the Persian Gulf, has flowed 2400 b.d. of 40°, 1·4% sulphur crude, from Lower Cretaceous Shuaiba limestone on limited test. Jurassic formations yielded gas. The well is 100 miles from the nearest production and is 8755 ft deep. J. C. M. T.

296. Petroleum prospects of Western parts of Great Australian artesian basin. R. C. Sprigg. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (10), 2465–91.—The deeper central and W. development of the Great Australian artesian basin is now considered to offer the most promising prospects for commercial oil on the Australian continent. Thicknesses of 5000 to possibly 10,000 ft or more of Mesozoic sediments, including several thousand feet of marine Cretaceous shales, overlie great and variable thicknesses of unmetamorphosed marine Upper Devonian, Ordovician, and Cambrian sediments in the central and W. basin areas. Metamorphism has affected these older sediments only in the E. part of the basin in Queensland and New South Wales.

Numerous oil and gas showings have been authenticated in the Mesozoic basin sediments in the shallower marginal zones of the basin, but the deeper areas remain virtually untested. Over the most interesting deeper parts of the basin, no bore has penetrated even the full section of the marine Cretaceous in an area of more than 160,000 sq. miles.

A recent development, which re-orients the Great Australian artesian basin as an oil prospect, has been the discovery of long lines of anticlines in the central basin area. E. N. T.

297. Yugoslavia—good undeveloped prospects. G. de Mohrenschildt. *Oil Gas J.*, 1.9.58, **56** (35), 156.—Yugoslavian oil prospects are restricted to inter-montane basins of small topographic relief in the republics of Serbia, Croatia, Bosnia-Herzegovina, Montenegro, and Slovenia. In Serbia part of the Pannonian basin has been explored and gas production is obtained from lenticular Miocene sands, often lapping buried igneous hills. Limited oil production is obtained from new fields at Lokve and Boka. Small but prolific fields are typical of Croatia, where production comes from the Miocene and Pliocene; an active water-drive is often present. Largest Croatian field is Klostar with 9 million brl primary reserves. Slovenia has two fields, Lendava and Nafta Lendava. Bosnia-Herzegovina and Montenegro have no production; the former has a very narrow Plio-Miocene basin with surface structures and one non-commercial oil discovery, the latter with important asphalt deposits and one 14,580-ft dry hole.
J. C. M. T.

DRILLING

298. Maximum hydraulic power at the bit. R. W. Colebrook. *World Oil*, 1958, **147** (5), 168.—Mud systems in drilling operations are being increased in h.p. in order mainly to increase bottom-hole hydraulic power, and systems of 1500–2000 h.p. are now being used. It is important to ensure that the max hydraulic power is supplied to bottom hole tools such as the turbo-drill and jet bits, and the theoretical means of maintaining this power are discussed. Two conditions are essential: losses in the mud system must be reduced to a minimum and the bottom-hole device must be matched to the system. It is shown that the hydraulic power at the bottom of the hole is highest when: (1) the bore through the drill string is the largest practicable; (2) mud weight is at a minimum; (3) surface mud pressure is the highest which is economically possible; and (4) mud flow rate and pressure drop across the bottom-hole device are at an optimum level. The optimum pressure drop is *ca* two-thirds of surface mud pressure and optimum flow rate is a function of hole and pipe dimensions, mud weight, and surface mud pressure. Equations are derived for computing these quantities. C. A. F.

299. Efficient drilling practices pay off in record Gulf Coast operations. E. C. Hallums and J. F. Earl. *World Oil*, 1958, **147** (5), 140.—Two wells drilled in the Caillou Island area, Louisiana, were drilled in record time as a result of efficient drilling techniques. A high penetration rate was obtained by using a rotary speed ranging up to 350 rev/min, with rig pumps of 850 h.p. Mud weights varied between 9·7 and 10·8 and bit loading varied from 25,000 to 60,000 lb. The first well was a 9⅞-inch hole, drilled to 13,178 ft in *ca* 14 days, and the second a 12¼-inch hole drilled to 12,500 ft in *ca* 12 days. Details of the drilling histories of these wells are given with tables showing drilling time breakdown. C. A. F.

300. Essentials of jet deflection drilling. R. W. Scott. *World Oil*, 1958, **147** (5), 137.—Directional drilling using a jet bit

instead of a whipstock has been successful in the Gulf Coast areas offshore from Texas and Louisiana, where formations are soft. The method consists of deviating the hole by applying a jet of mud through the bit. The bit has the normal 3-jet nozzles, one of which is about twice the dia of the others, so that, by orienting the bit in the required direction and pumping mud at a high rate through it, a strong washing action is directed against the hole in the direction of deviation. During the jet action the pipe is reciprocated over a height of 6–8 ft to wash the sides of the hole. The washed part of the hole is then drilled and the washing or " jetting " procedure is repeated as required. The technique has several advantages over the conventional whipstocking: (1) it is quicker, and round trips can be eliminated; (2) the " dog leg " hazard is reduced; (3) a more gradual deviation can be obtained during the " kick off "; and (4) deviations up to 5° per 100 ft are possible. There have been large savings in costs since the method was introduced in the area.

Precautions to be taken are outlined, and diagrams showing the equipment are included. C. A. F.

301. Controlling corrosion in high pressure wells. M. J. Epperson. *Drilling*, Oct. 1958, **19** (12), 86.—Corrosion inhibitors, plastic coatings, or corrosion-resistant tubing are currently used to control corrosion in high pressure wells, the first being the most popular, despite the disadvantage that it may be necessary to shut a well in periodically to treat it. Plastic coatings suffer from the disadvantage that local damage to the coating—almost inevitable during running-in tubing—may allow local and accelerated corrosion. A combined programme of plastic coating and use of small amounts of inhibitors may provide max protection at reasonable cost. Corrosion-resistant materials could be the most efficient answer to corrosion, but are not yet popular. J. C. M. T.

302. Bottom hole hydraulics. R. W. Colebrook. *Drilling*, Oct. 1958, **19** (12), 82–3.—In order to get the highest possible proportion of available pump power at work at the bottom of the hole, mud system losses must be kept to a minimum, and the down-hole device matched to the rest of the system. Losses are minimized by using the largest bore and lightest mud which hole conditions permit. Surface mud pressure should be the highest which can be maintained economically. The bottom-hole device may be a jet bit or some form of turbine or other motor, but in all cases should be arranged to give a pressure drop of *ca* $\frac{2}{3}$ the surface mud pressure in order to obtain max bottom-hole hydraulic power. J. C. M. T.

303. Blowouts can be controlled with stinger closure device. W. E. Harrelson and J. E. Ortloff. *Drilling*, Oct. 1958, **19** (12), 80–1.—The stinger closure device is an insert-type tool based on a Jersey Production Research Co. patent, intended to be ready on the rig floor in case of emergency. The device comprises a hydraulic cyl and piston with a packer attached to the end of the piston rod. It can be attached to the top of the casing by slip-type elevators and links, out of the path of the blowing stream. Raising the tool to a vertical position and applying hydraulic pressure to the top of the piston plunges the packer into the bore. Details of design provide for progressive control of the flow and finally for pumping fluid down the well. Time to close the well is 15–20 sec. Drawings showing construction and operation are given. J. C. M. T.

304. Tests indicate separation to blame for fluid knock. S. L. Collier. *Drilling*, Oct. 1958, **19** (12), 78.—The sound produced by mud pumps under certain conditions, variously known as valve-hammer, valve knock, or fluid hammer, has been shown to be a hydraulic knock. It is due to separation of the mud column in the cyl from the piston during the first part of the suction stroke (as a combined effect of the acceleration of the piston and high inertia of the mud) followed by the violent filling of this void by the mud as the piston slows down past the mid-stroke position. The knock may be combated by shortening the suction line or increasing its dia, by using suction chambers, increasing the flooded suction level, and cooling the mud if temp tend to be high. Supercharging is a positive solution. J. C. M. T.

305. Stearates used to prevent balling of moist cuttings. B. V. Randall, J. L. Lummus, and R. P. Vincent. *Drilling*, Oct. 1958, **19** (12), 76–7.—Zinc and calcium stearates, by their water-repellent characteristics, prevent agglomeration of bit cuttings in the presence of water production ranging from trace amounts to *ca* 2 brl/hr, in air- and gas-drilled wells. Zinc stearate is limited in use to temp below 250° F, calcium stearate to less than 300° F; the lithium salt may be useful up to 390° F. Zinc or calcium stearate should be added at a rate of 1–4% of the weight of the cuttings. A device for injecting the stearate in powder form into the air or gas stream, against pressures of up to 750 p.s.i., has been developed. Besides their anti-balling attributes, the stearates cause an appreciable reduction in friction between the drill pipe and the hole. J. C. M. T.

306. Sample trap collects air- or gas-drilled samples. K. E. LaPrade. *Oil Gas J.*, 4.8.58, **56** (31), 86.—A simply made inexpensive sample trap for air or gas drilling is illustrated and described. The essential features are an adjustable baffle which deflects air- or gas-suspended particles downwards into a collecting chamber, from which they are simultaneously ejected via a quick opening or shutting valve at the base. The device can be fitted anywhere in the exhaust line, remote from the danger zone at the outlet. Useful geological information can be obtained from the samples if the high power of a binocular microscope is used. J. C. M. T.

307. Turbo-drill reduces costs in Illinois gas-storage project. Anon. *World Petrol.*, 1958, **29** (10), 80.—Gas is being stored underground in the Herscher dome, *ca* 55 miles SW. of Chicago, as a reservoir for supplying natural gas to the Chicago area. Two water sands in the structure, the Galesville at *ca* 1500 ft and the Mount Simon at *ca* 2500 ft, have been found suitable for storage. Water is pumped out of the reservoirs to permit gas entry and is re-injected into an upper bed. Recent expansion of the project has required ten wells into the lower reservoir, eight of which have been drilled mainly by turbo-drill, which gives a better performance than rotary in the area. Rate of penetration is increased, the hole is straighter, and costs are lower. A typical well programme is given briefly. C. A. F.

308. Cutting carrying capacity of air at pressures above atmospheric. K. E. Gray. *J. Petrol. Tech.*, 1958, **10** (8), AIMME Tech. Paper No. 8024, 180–5.—Experimental studies have been made to determine the drag coeff for particles in air streams such as are used in air drilling. Newton's law has been converted to a more useful form by the use of drag coeff for flat particles (limestones and shales) and angular or subrounded particles (sandstones).

$$V_s = K\sqrt{D(0{\cdot}371T\rho_s/P - 1)}$$

For shale and limestone $K = 1{\cdot}6$ and for sandstone $K = 2{\cdot}1$. V_s is slip velocity, P bottom-hole injection pressure (p.s.i.a.), T bottom-hole temp ° R, ρ_s particle density (lb/ft³), D particle dia (inch).

Comparison has been made between the velocities needed to lift particles and those calculated from the equations. Plots of slip velocity against bottom-hole injection pressure are given for different particle sizes. The 3000 ft/min linear velocity of free air commonly recommended is sufficient only to remove small rock particles.

H.p. requirements may be reduced by cycling high-pressure air. G. D. H.

309. Concrete pile foundation for over-water drill sites. G. A. McCammon. *Drilling*, Oct. 1958, **19** (12), 69–71.—The history of the concrete well foundations used successfully by the Lago Petroleum Corpn (now part of Creole) for 25 years in Lake Maracaibo is described. Concrete piles supporting a steel-frame platform were adopted in 1933 to combat corrosive conditions and attack by the teredo. One inclined and two vertical piles were used at each corner, tied together by a concrete cap poured *in situ*, supporting the steel platform. None of the standard foundations which have been used has deteriorated, and some have already outlasted the wells drilled from them. J. C. M. T.

PRODUCTION

310. Engineered completions increase oil recovery. R. W. Coburn. *World Oil*, 1958, **147** (5), 173.—Recent improved perforating and fracturing methods have given more efficient well completions, and these developments, including perforating and fracturing procedures, and the evaluation of the completion, are described. It is shown that selective perforating and lower shot density reduce the tendency of the cement to disintegrate and cause fracture failure. Engineered stage fracturing should give more effective drainage and greater ultimate recovery. The use of pressure behaviour during stage treatment for calculating the efficiency of the treatment is described, and case histories are given of treated wells. C. A. F.

311. Maximum recovery—how far have we come? V. E. Stepp and E. R. Brownscombe. *Oil Gas J.*, 1.9.58, **56** (35), 171–5.—In this survey of the progress in theory and practice of oil recovery the authors describe the essential features of water flooding, gas injection, miscible displacement (high pressure and propane-slug), and CO_2 displacement methods. The fallacies of the concept of reservoir energy as the factor controlling recovery, and of restricting the flow in solution-gas-drive reservoirs to improve recovery are touched on. The importance of economics among the factors of efficient recovery is stressed, while of the purely physical factors rock wettability should be given more attention than it has been. One of the greatest needs is the development of a cheap substance, miscible with both oil and water, to combine the high recovery of the miscible displacement recovery method with the high sweep-out efficiency of water flooding. J. C. M. T.

312. Successful propping of fractures. J. L. Huitt and B. B. McGlothlin. *Oil Gas J.*, 8.9.58, **56** (36), 92–5.—High overburden pressures tend to cause an induced fracture to collapse by (1) crushing the introduced sand grains, or (2) causing embedment of the sand grains into the formation. In designing a fracture programme these factors must be allowed for. Assuming that the first may be neglected, the width, W, of a fracture may be calculated from the expression:

$$W = D[1 - B(Pe/nD^2)^m]^{\frac{1}{2}}$$

where D = grain dia of propping sand; Pe = effective overburden pressure (overburden-reservoir pressure); n = number of sand grains/sq. in. of fracture; B and m are constants characteristic of the formation. Values of m and B can be obtained experimentally on cores using a ball-point penetrometer to determine depth of penetration of ball points of various dia at various loads and using the relation:

$$d/D = B^{\frac{1}{2}}(L/D^2)^{m/2}$$

where L is the load and d the dia of the impression resulting from the penetration of the ball point. Allowance must be made for fluid leak-off in deciding the sand concn needed to give an appropriate value of n. The probable decline in reservoir pressure must also be considered, since this will increase the effective overburden pressure. J. C. M. T.

313. Mathematical treatment of petroleum deposit flooding. (In German.) D. Marsal. *Erdöl u. Kohle*, 1959, **10**, 825–6.—To study petroleum deposit flooding Darcy's law is extended by introducing relative permeabilities with regard to capillary forces. Mathematical formulation of these insertions gives complicated partial differential equations. Two-dimensional problems are studied on hydrodynamic or electric models. For mathematical investigation of these problems and selective flooding in inhomogeneous reservoir rocks, a procedure—fundamentals and application possibilities presented—is developed. Initial flooding investigation commences with a core saturated with oil and adhesion water, into which a water front is injected. Two integral magnitudes are pressure fall Δ_p between the core ends, and the medium oil saturation $\bar{s}_0$ of the core in dependence on a dimensionless time t_D, defined through the cumulative water injected to the pore vol of the core. From the functions $\Delta_p = \Delta_p(t_D)$ and $\bar{s}_0 = \bar{s}_0(t_D)$ two new functions f and ϕ are determined which, in first approximation, depend on oil saturation $\bar{s}_0$ at one point and flow rate U of the total oil and water stream and are defined by: (1) $u_0 = f.U$, and (2) U = $-\phi$ degree p. Dependence of f and ϕ on U is small, so that it suffices to determine $f = f(s_0)$ and $\phi = \phi(s_0)$ for three different injection rates U in relation to 1 : 10 : 100. Equation (2) is a generalized Darcy law for total gas flow. Removing rates u_0 and U from equations (1) and (2) with the help of the continuity equations (assuming that the flowing liq are incompressible), (3) div U = 0, (4) div $U_0 = -\Phi\frac{\partial s_0}{\partial t}$ (Φ = porosity). For p and s_0 as functions of time and place the system is obtained (5) div (ϕ degree p) = 0, ϕ degree f degree $p = \Phi\frac{\partial s_0}{\partial t}$. These equations can be solved easily for the case of linear flow through parallel-connected layers of various physical properties. R. T.

314. The Spraberry can be flooded. L. F. Elkins. *Oil Gas J.*, 30.6.58, **52** (26), 64–7.—The Spraberry is a 1000-ft section of Lower Permian sands and shales, with a 30-ft productive sand at the top and a lower productive sand 25 ft thick, both of which yield production from an extensive vertical fracture system. The sands themselves are tight. After a high initial exploitation in 1951–52, gas–oil ratios became high, production declined to an average of 19 brl/well, and 445 wells have been abandoned or plugged. Oil in place is estimated at 6000 brl/acre in Upper Spraberry and perhaps 3000 brl/acre in Lower Spraberry. Cumulative production to date is only 500 brl/acre. Apparently the sands are strongly water wet, and in lab tests water will replace oil in cores. Two pilot water flood schemes gave increased production and decreased gas–oil ratios, suggesting that water entered the sands and flushed oil into the fissures. Data also suggest the fracture system is pressure sensitive, closing up as pressure declines, but re-opening when pressure is restored. On the basis of these pilot schemes a unitized flooding scheme is proposed. J. C. M. T.

315. Water-flood oil recovery is lessened by restricting rates. J. F. Buckwalter *et al.* *Oil Gas J.*, 16.6.58, **56** (24), 88–99.—There are discrepancies between lab model results and field experience over the question of the effect of rate of production on total recovery in water-flood projects. The authors believe that restricted production rates may diminish oil recovery, partly because at low production rates oil extraction may become uneconomic before it would have done at higher

rates, and partly because of physical reasons concerning the behaviour of fluids in real reservoirs, not adequately reproduced in lab models. More research is needed. J. C. M. T.

316. Investigations on the influence of interfacial tension and contact angle on oil displacement by water in porous bodies. (In German.) W. von Engelhardt and H. Lübben. *Erdöl u. Kohle*, 1957, **10**, 747–52, 826–30.—Pt 1. Theoretical principles and experiment performance. Pt 2. Results of experiments. Use of interfacial-active materials in deposit treatment.—Pt 1. The starting point of the investigations is Leverett and Buckley's theory of multiphase flow based on examples of hydrocarbon displacement from a cyl rock body by other phases. The assumption that relative permeabilities alone are a function of saturation is untenable if the influence of interfacial tension and contact angle is to be realized. Influence of capillary forces and displacement rate on phase distribution is investigated with a simple model of two bundles of straight capillaries of circular cross-section and different radii r. Contact angles were respectively $<90°$ ($\cos\theta$ positive), and $>90°$ ($\cos\theta$ negative). Since phase distribution on large and small pore cross-section is practically independent of $\sigma\cos\theta$, at high rates, independence of relative permeabilities, at high rate only, must be expected. Only at high rates also, can Buckley and Leverett's ideal case—that relative permeabilities are clear functions of total saturation—be realized. At low rates, on the contrary, the saturation picture in detail is determined by $\sigma\cos\theta$, therefore relative permeabilities must be dependent on $\sigma\cos\theta$. With positive $\sigma\cos\theta$ the displacing phase is held preferably in the small capillaries; therefore at the same total saturation the flow resistance of the displacing phase decreases with greater $\sigma\cos\theta$. With positive θ relative permeability of the displacing phase for a definite total saturation diminishes with decreasing rate, with negative $\cos\theta$ it rises with falling rate. The reverse is true for the displaced phase. Relative permeability in dependence on saturation may be measured by electrical resistance readings in the flow-direction. Execution of the method described and illustrated is presented. 22 refs.

Pt 2. Estimations of oil displacement from packings of hydrophilic and hydrophobic glass balls with dist H_2O and Hostapal soln at flow rates of 10·67, 1·10, and 0·213 cm/hr were made. Oil and H_2O vol were measured in dependence on time, thus giving an average oil recovery degree in %. At all rates the oil recovery degree $(1-\bar{s}_0)$ at a definite oil flow increases. In oil-wetted systems ($\cos\theta$ negative) therefore, the oil recovery degree is always $<$ in the H_2O-wetted system. The influence of interfacial forces on oil recovery is so much stronger the longer the displacement proceeds. The oil recovery degree reached at a definite f_0 is the greatest at a large positive $\sigma\cos\theta$ at slower rates; on the other hand, at high-negative $\sigma\cos\theta$ the strongest oil recovery is attained at high rates. Before deciding on yield increase effect of interfacial active materials and rate of flooding, the contact angle size between rock, oil, and water must be determined; it may be assumed that the bearer rocks are hydrophylic. Since lowering of the interfacial tension oil/H_2O is the aim, and this effect is connected with an enrichment of the active agent, a certain loss of substance by adsorption at the oil/water contact must be considered. Disadvantages of cationic and anionic substances are indicated. Non-ionic interfacial active substances alone are applicable. 13 refs. R. T.

317. Material balance for oil pools. G. D. Hobson. *Petroleum, Lond.*, 1958, **21** (10), 352–6.—The material balance relationships for oil pools are based on equating the vol of the hydrocarbon contents of a reservoir rock at a given time to the vol of the materials occupying that same space at a later time. The latter vol represents the remaining hydrocarbons and any water that has moved into the space under consideration. Some oil accumulations are markedly under-saturated with gas and can produce considerable amounts of oil before the pressure on the accumulation as a whole falls below the bubble point pressure. Others are saturated and may be associated with large vol of free gas in the form of a gas cap.

Methods of calculating material balance above and below the bubble point pressure are described, and the effect of water on production is discussed. Material balance relationships afford a basis for the estimation of oil reserves when associated with knowledge of the dominant producing mechanism and characteristics of the reservoir rock and the crude oil. It has also been used in conjunction with other concepts to predict the behaviour of an oil accumulation when controlled in different ways. It aids in estimating the relative merits of using only the natural forces and of supplementing them by injection of gas or water, or both, into the reservoir.

M. F. M.

318. Fire-flood works, but costs are high. Anon. *Oil Gas J.*, 1.9.58, **56** (35), 106–7.—Thermal recovery of oil from a reservoir has been investigated by a three-year experiment conducted by General Petroleum Co. in S. Belridge field, Kern County, California—a typical low primary recovery, heavy crude field. A 2½-acre five-spot pattern was used. Air was injected at 500 p.s.i. and 100° F. Combustion occurred spontaneously 3½ months after injection was started, and production increased two weeks later from 20 b.d. to as much as 300 b.d. for short periods. *Ca* 50% of the oil in place was recovered within 18 months of ignition. In ordinary circumstances expected recovery would be 10–15% in 40–60 years. Overall cost of experiment ($1 million) exceeded by several times the value of oil produced as a result of severe corrosion and other production problems in the producing wells, especially as the combustion front approached them, leading to need for drilling two replacement wells and providing them with stainless steel liners. J. C. M. T.

319. Sonic pump is ready. Anon. *Oil Gas J.*, 7.7.58, **56** (27), 66.—The sonic pump uses no walking beam or sucker rods; instead the entire tubing, fitted with check valves in the tubing connexions, is vibrated vertically by means of a mechanical oscillator located at the surface. The "stroke" is 0·3–0·5 inches and the frequency of oscillation *ca* 600–12,000 cycles/min according to tubing length. Electric or I.C. engine drive may be used. First cost and maintenance costs are low, and the pump can handle low gravity oil with a high sand content. Disadvantages are possibility of tubing failure, necessity for pulling the tubing "wet," and no way of determining fluid level. J. C. M. T.

320. Streaming potential and the SP log. M. Gondouin and C. Scala. *J. Petrol. Tech.*, 1958, **10** (8), AIMME Tech. Paper No. 8023, 170–9.—Lab measurements of streaming potentials under high pressures have been made on mud cakes, the results confirming data reported previously. Appreciable streaming potentials were also obtained across shale samples. In both cases the potentials depended on the nature and concn of the impregnating electrolyte, but the pressure effects differed, presumably as a result of differences in compressibility. Generally the differences in the streaming potentials of the shales and mud cakes were small, but in practice much might depend on the actual shale–mud cake combination, or on an unusual pressure distribution, *e.g.* depleted sand. For high resistivity muds and high pressure differentials (1500 p.s.i.) the extent of compensation of the two potentials depends basically on the electrokinetic properties of the shales and mud cakes. For low resistivity muds the two streaming potentials are small and their difference may not be important on the SP log.

Some field measurements are described. G. D. H.

321. Zechstein profiles in the region Barnstorf–Diepholz–Rehden–Wagenfeld. Facies characteristics in the Stassfurt series. (In German.) H-J. Fabian. *Erdöl u. Kohle*, 1957, **10**, 741–7.—In the space of the Rehden gas field—with current production at the peak of the natural gas fields of the Federal Republic—many wildcat and production borings have been sunk for Zechstein investigation. Further gas occurrence has been disclosed with Düste-Z1 *ca* 12 km N. of Rehden. W. and E. of Rehden further borings have been sunk at Aschen, Diepholz, and Wagenfeld, only one being oil- or gas-bearing. Previous explanations of these Zechstein profiles have been submitted to critical inspection and modified. Especially in the Stassfurt series (Zechstein 2), facial peculiarities hitherto unknown, but of practical importance, merit attention.

R. T.

OILFIELD DEVELOPMENT

322. World exploration boom. Anon. *World Petrol.*, 1958, **29** (10), 67.—Exploration in terms of annual number of wells drilled has increased by *ca* 300% since the end of the war with the finding of major fields in the E. and W Hemispheres. This activity has increased during 1958, and outside the U.S.A. a record number of wells is being drilled. World-wide drilling and exploration developments are briefly outlined by countries and areas. C. A. F.

323. Some considerations of petroleum development in Central America. J. W. Flude and G. Underwood. *World Petrol.*, 1958, **29** (10), 82.—For political reasons, Central America is important as a potential oil-producing area, which, apart from countries bordering the S. Caribbean sea and Mexico, has not yet been intensively explored. The region of interest extends from British Honduras and Guatemala in the N. to Panama in the S., and there are bordering continental shelves of considerable area which may be of greater value than the land areas. Exploratory wells are now being drilled in several countries; to date most wells have been drilled in Panama. In Costa Rica two wells are reported to have had significant shows, and a Tertiary marine section of over 10,000 ft has been found in the area.

The Peten area of Guatemala is also being actively explored, but communications are poor and exploration is costly and difficult. C. A. F.

324. Germany nears 100,000 b.d. A. M. Stahmer. *World Petrol.*, 1958, **29** (12), 55.—Oil production in W. Germany is expected to reach 100,000 b.d. by 1959 or 1960, and recent drilling has indicated that promising discoveries may still be found in shallow formations which have so far produced most of the oil. Active geophysical exploration and drilling are continuing and at the beginning of 1958 total proved and probable reserves were estimated at *ca* 69 million metric tons, 2·4 million tons higher than for the previous year. The most important producing rocks are in the Cretaceous, particularly the Wealden and Valendis, but reservoirs have also been found in the Jurassic, Tertiary, Trias, and Permian. In S. Germany only the Tertiary is productive.

During 1958 most of the new discoveries have so far been in the Weser–Ems district, details of these being given, but there have also been finds near Brunswick, and in Emsland and the Upper Rhine Valley. In the Alpine foreland oil has been found near Memmingen in Wurttemburg, and there were two new finds E. of Munich.

German overseas operations have been extended, so far with little success, but oil has been found in a well at Maquia in Peru, E. of the Andes. Operations are also being carried out, partly with joint or acquired interests, in Spain, Greece, Turkey, Syria, Switzerland, Saskatchewan, Algeria, and Libya. C. A. F.

TRANSPORT AND STORAGE

325. Multiphase flow in pipelines. O. Baker. *Oil Gas J.*, 10.11.58, **56** (45), 156.—When a mixture of gas and oil enters a pipeline, the gas separates and flows rapidly down the pipe, leaving oil behind, and begins to accumulate in the pipeline. When equilibrium is reached as much as 80% of vol of pipe is occupied by oil.

A number of design and annual flow equations are given, effect of hills, hold-up, and pressure is stated and equations are compared; a table shows comparison of two-phase pressure drop correlations. G. A. C.

326. Transducers protect large centrifugal pipeline pumps. W. W. Holt. *Oil Gas J.*, 3.11.58, **56** (44), 71.—A review is given of custom-built electronic protective devices against pressure temp, and vibration in large unattended pumping units. New equipment provides greater accuracy and increased rates of response of the temp, pressure, and vibration shutdown functions. G. A. C.

327. Dents in pipe. S. P. Belonos and R. S. Ryan. *Oil Gas J.*, 17.11.58, **56** (46), 155.—A series of tests to determine effects of internal pressure, residual stress, and static internal pressure at failure show that the metal in and adjacent to the dent contains some residual stresses even though the metal yields. Strain gauges were used to show that this residual stress increases with depth of dent, and decreases with dent area. Tables show pressure and residual stress summary for 20 m o.d. pipe, and results of burst tests. G. A. C.

328. Photogrammetry. M. E. Fuller. *Oil Gas J.*, 27.10.58, **43** (56), 89.—The method of photogrammetry to survey pipeline routes removes need for surveyors in the field, and greater accuracy is obtained, especially over rugged terrain. Aluminium targets were used to locate various points. A description is given of the aerial photography and processing and a comparison made between aerial and ground survey.

G. A. C.

329. Underground storage for hydrocarbon fluids. B. L. Loofbourow. *Petroleum, Lond.*, 1958, **21** (10), 347–51.—Artificial underground storage is not particularly new, but storage of large vol of hydrocarbon fluids directly against rock, without lining of any kind, is comparatively recent. Several categories of storage are used, depending on capacity required.

Reasons for rapid growth of industrial underground storage are: lower unit capital and maintenance costs, less evaporation loss, less deterioration of products, and less hazards. Four types of underground storage are described in the paper, and these are: (1) storage in depleted gas or oil reservoirs; (2) abandoned mines and quarries; (3) cavities dissolved in salt beds or in salt domes; and (4) excavations mined for storage. Much of the paper is concerned with type (4). Storage of LPG, natural gas, and crude oil in such reservoirs is discussed. Cost factors are considered and comparison is made of approx capital costs of various types of surface and underground storage. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

330. From flow sheet to cost estimate. W. E. Hand. *Petrol. Refin.*, 1958, **37** (9), 331–4.—A short cut method of estimating approx costs of a plant without the aid of sketches of piping, structures, etc., is a worthwhile tool for use in process evaluation. The first requirement for making a capital cost estimate is a process flow sheet. The charts and tables of cost of equipment are then essential. The third and final requisite is a set of installation factors or multipliers relating total battery limit costs to equipment costs based on past experience with similar process plants.

Comprehensive data are included in this paper on the cost of fractionating columns, shells, pressure vessels, heat exchangers, tanks, furnaces, pumps, compressors, and instruments. An example is given of the use of the underlined technique for estimating the approx cost of a hypothetical process plant. M. F. M.

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332. How to scale-up pilot plant data and equipment. E. L. Clark. *Chem. Engng*, 1958, **65** (20), 129–40.—In order to scale up a system some basis should be set up for maintaining a relationship between the results in a small system and those to be predicted for a larger system. The author considers first the organization of observed data, the most important of which are the effects of temp, pressure, time, and concn of the reactants. Very often these effects can be expressed as functional relationships. Kinetics of simple and complex reactions are then considered. In many cases of complex reactions—particularly for heterogeneous reactions where cat or reacting surfaces are involved—an empirical approach is needed to organize the data. The simplest type of expression of some generality might be the rate of reaction as a function of some power of the reactant, product, or diluent concn.

$$\text{Rate} = k(P_A)^n(P_B)^m(P_C)^o$$

where A and B might be reactants and C a product; P represents the partial pressure or concn; m, n, and o are numerical constants; and k is the rate constant for the reaction.

Considerable information has accumulated recently for the transference of results from small to large equipment. Donkohler suggests five dimensionless groups which can be used as means of equating conditions in large and small reactors. These dimensionless groups and their application to design and scale-up of equipment are discussed in the paper. Both homogeneous and heterogeneous reactions are considered and numerical examples are included.

System scale-up is far from an exact science, although one certainly can use scientific techniques to its accomplishment. M. F. M.

333. Burner consumes wastes and residual fuels. C. C. van Soye. *Chem. Engng*, 1958, **65** (21), 86.—A new type of burner called "Thermal Vortex burner" has been developed by Thermal Research and Engineering Corpn which operates on a wide range of fuels, including asphalts, short residuum, acid sludges, solvents, or any gas. Simultaneous firing of oil and gas is possible. Heat release rates vary from 1 million B.t.u/hr. (cu. ft.) to 3 million B.t.u/hr (cu. ft.). Essentially the Vortex burner consists of an air plenum chamber, swirl-vane assembly, burner barrel, controls, and refractory-lined combustion cyl. No external combustion chamber or furnace is required. Flow diagram and details of construction and performance are given in the paper. M. F. M.

334. Development of a refinery simulation programme. J. S. Bonner *et al. Chem. Engng Progr.*, 1958, **54**, 101–6.—The purpose of this article is three-fold: first, to define the basic problem facing the refinery economist; secondly, to discuss plant simulation by an electronic computer as an aid to the economist and to present the requirements and properties of a satisfactory plant simulation procedure; and thirdly, to illustrate these requirements by specific examples taken from an actual refinery simulation programme. The major part of this paper has been devoted to the third objective. The authors have attempted to give a sound picture, both of the degree of perfection which can reasonably be expected from such a programme and of the magnitude of the time and effort which must go into its preparation and use. G. W. T.

335. A different kind of bundle cleaner. Anon. *Oil Gas J.*, 27.10.58, **43** (56), 84.—A new jetting tool is described for cleaning heat-exchanger tube bundles which removes many deposits which could not be removed satisfactorily by other methods. Various jet heads are used to deliver 65 gal/min to 175 gal/min at 3000 psi. The cleaner consists of a hydraulic jetting head fastened to a movable beam extending two bases. The jet head is mounted on a trolley motor propelled along the supporting channel beam. G. A. C.

ABSORPTION AND ADSORPTION

336. Nomogram for tower packing height. Liang-Tsen Fan. *Petrol. Refin.*, 1958, **37** (9), 346.—Capacities of packed absorption towers, both commercial and pilot plant scales, are often represented by the overall mass transfer coeff (K_GA), which is calculated for the following equation:

$$K_GA = \frac{N}{\frac{h\Delta P_2 - \Delta P_1}{\ln \frac{\Delta P_2}{\Delta P_1}}}$$

where N = rate of absorption in lb mol per (hr) (sq. ft.); h = height of packing, ft; P_2 = driving force at bottom of tower packing; P_1 = driving force at top of tower packing. Based on the above equation, a nomogram is presented and its use is illustrated by an example. M. F. M.

337. Adsorption process now practical for recovery of natural gas liquids. W. M. Dow. *Oil Gas J.*, 3.11.58, **56** (44), 74.—A field processing method is given for treating relatively small or lean gas streams using a dry extraction process. The combination LPG and gasoline recovery unit has four adsorbing towers, both silica gel and activated carbon being adsorbents. Tables show performances of actual adsorption installations for various-sized towers, economies of the process, and comparative recoveries for moderately rich and very lean gas condensate fields. G. A. C.

SOLVENT EXTRACTION AND DEWAXING

338. Use graph to design for optimum economic extraction. R. S. Olson. *Chem. Engng*, 1958, **65** (20), 143–5.—Solvent extraction is often set up as a counter-current, multi-stage operation. The effectiveness of this operation is fixed by feed rate, distribution coeff, and the number of theoretical stages required. Optimum operating conditions can be obtained by calculating the efficiency at several values of the operating variables, but this is a long, tedious, and time-consuming procedure. In this paper, a chart is provided which correlates the optimum number of stages, the extraction factor, and recovery. Although this chart is designed for linear distributions, it may be used with some accuracy on systems which are only moderately linear.

Two examples, the first on counter-current decantation and the second on solvent extraction, are given in the paper as a guide to the use of the chart and in helping the reader to solve more complex problems. M. F. M.

CRACKING

339. Hydrogenating cracking of petroleum residues. (In German.) D. H. Stevenson and H. Heinemann. *Brennst-Chemie*, 1957, **38** (15–16), 243–6.—A process is described for hydrogenating cracking of petroleum residues at 250 atm pressure. Continuous working at this pressure for extended periods is made possible by using a light hydrocarbon, *e.g.* butane, as diluent in the introduced material. Excellent yields of light and medium dist are obtained with definite cat; H_2 consumption is relatively low. Co–Mo–oxide cat on Al_2O_3 is the best for this purpose. The resulting gasoline is suitable for cat reforming; the synthetic gas oils resemble fresh gas oils and are cracked easily. From an economical viewpoint relatively high installation costs and normal amortization time result. If the requirement for different products changes, the process can be also economically attractive. 10 refs. R. T.

340. The thermal cracking of *n*-hexadecane as a homogeneous step-by-step reaction of the first order conducted in stream. (In Russian.) G. M. Panchenkov and V. Ya. Baranov. *Khim. i Tekh. Topliva i Masel*, 1958, (9), 24–8.—If the rate of thermal cracking of *n*-hexadecane is judged according to the yield of 285° final b. p. fraction, then this reaction can be regarded as a step-by-step reaction:

$$A \xrightarrow{k_1} v_1A_1 + V_2A_2 + V_3A_3 \xrightarrow{k_2} V_4A_1 + V_5A_2$$

Equations are derived for the yield of intermediate product and the rate constants for the first and second stages of the thermal cracking reaction. When the degree of conversion is less than 0·6 the equation of the first order step-by-step homogeneous reaction becomes an equation for a simple first order reaction flowing in stream. G. W. T.

341. Investigations on hydrocarbon cracking in the electric arc. (In German.) G. A. Fester, E. A. Martinuzzi, and A. I. A. Ricciardi. *Erdöl u. Kohle*, 1957, **10**, 840–2.—Experiments are described on liq hydrocarbon cracking—with the luminous arc below the liq surface—in the illustrated apparatus. In petroleum or diesel fuel oil cracking with Zn, Hg, or Pb cathodes higher C_2H_2 yields were obtained than with Fe, C, or Cu electrodes; intermediate yields were obtained with Al electrodes. R. T.

342. Production of olefinic gases by cracking hydrocarbons. (In German.) H. Pietsch. *Erdöl u. Kohle*, 1957, **10**, 837–40.—The known autothermic process for C_2H_6 and C_3H_8 hydrocarbon cracking to olefins is applied to light gasoline cracking. Conventional cracking of C_2H_6 with O_2 is very temp-sensitive. At 800° C the yield is 13 wt %; yields increase rapidly to max 60 wt % at 900° C. Light gasoline cracking shows a conversion degree comparable with tube pyrolysis. Olefin yield at one throughput is 20 wt %; this is increased by recirculation, whereby fixing of current operating conditions is determined by local processing possibilities. 8 refs. R. T.

343. Cat cracker sets challenges. C. H. Chilton. *Chem. Engng*, 1958, **65** (20), 120–3.—Tidewater Oil's giant Orthoflow fluid cat cracking unit at Delaware with the design capacity of 102,000 b.d. stands as the largest such unit in the world. It consists of a single 200-ft high converter vessel which houses the reactor and cat regenerator. The 60-ft dia regenerator is mounted on top of the reactor vessel which contains the cat stripper in its centre section. Max total weight is 9500 tons. To circulate and regenerate 85 tons/minute of cat an Ingersoll-Rand centrifugal blower with a capacity of 137,000 s.c.f.m. driven by an 11,250-h.p. turbine is used. To help good cat distribution two risers and four stand-pipes are used, together with a large number of oil inlets to the reactor (28, including those for recycle), to assure good contacting throughout reactor and regenerator. 16 cyclones in the reactor and 60 in the regenerator separate the entrained cat. Feed used is a mixture of virgin and fluid coker gas oils and the cat bed temp is maintained at *ca* 900° F. M. F. M.

ALKYLATION

344. Alkylation—what you should know about this process. R. E. Payne. *Petrol. Refin.*, 1958, **37** (9), 316–29.—This comprehensive article describes the many factors which influenced the alkylation process and its products. Detailed descriptions and flow diagrams of sulphuric acid and hydrofluoric acid alkylation processes are given, and a summary of U.S. alkylation capacity, in tabulated form, is included.

The products of hydrofluoric and sulphuric acid alkylation differ somewhat because the plants are operated at different conditions. The more important variables affecting the product quality are *iso*butane concn, olefin space velocity, reaction temp, cat strength, olefin injection, and mixing. These are all considered in detail.

The economics of hydrofluoric and sulphuric acid alkylation methods are compared. Since this shows that the two methods are economically close in most cases, plant selection is often based on the availability of each cat and the ultimate octane requirement. M. F. M.

345. Free radical alkylation of *iso*butane with ethylene. J. A. Ridgway, Jr. *Industr. Engng Chem.*, 1958, **50** (10), 1531–6.—Present processes for the free radical alkylation of *iso*butane with ethylene produce neohexane in much less than the theoretical yield. To improve yield, reaction conditions have been studied and a search for effective reaction modifiers has been undertaken. Temp was the principal variable considered: yields improved with increasing temp to an estimated 40% theoretical at 750° F. Little advantage was indicated for higher temp.

Of the potential modifiers studied, only the halogens were effective. The best of these was ethyl bromide. The 40% estimated yield of the unmodified process was increased to over 70% by the addition of 0·4 mol % ethyl bromide on ethylene charged. M. F. M.

346. Recent advances in alkylation with sulphuric acid. (In German.) P. W. Sherwood. *Erdöl u. Kohle*, 1957, **10**, 853–6.—A sudden new swing of alkylation is caused by the rapid rise in motor gasoline O.N., whereby premium fuels already approach the O.N. range of aviation gasolines. Means for raising O.N. are max TEL addition, intensified cat cracking, broadening and intensification of reforming, and alkylate introduction. Polymerization and alkylation for converting C_3- and C_4-hydrocarbons into strongly branched, *i.e.* knockproof, mol in the gasoline boiling range are compared. Advantages and disadvantages of H_2SO_4 and HF

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333. Burner consumes wastes and residual fuels. C. C. van Soye. *Chem. Engng*, 1958, **65** (21), 86.—A new type of burner called "Thermal Vortex burner" has been developed by Thermal Research and Engineering Corpn which operates on a wide range of fuels, including asphalts, short residuum, acid sludges, solvents, or any gas. Simultaneous firing of oil and gas is possible. Heat release rates vary from 1 million B.t.u/hr. (cu. ft.) to 3 million B.t.u/hr (cu. ft.). Essentially the Vortex burner consists of an air plenum chamber, swirl-vane assembly, burner barrel, controls, and refractory-lined combustion cyl. No external combustion chamber or furnace is required. Flow diagram and details of construction and performance are given in the paper. M. F. M.

334. Development of a refinery simulation programme. J. S. Bonner *et al. Chem. Engng Progr.*, 1958, **54**, 101–6.—The purpose of this article is three-fold: first, to define the basic problem facing the refinery economist; secondly, to discuss plant simulation by an electronic computer as an aid to the economist and to present the requirements and properties of a satisfactory plant simulation procedure; and thirdly, to illustrate these requirements by specific examples taken from an actual refinery simulation programme. The major part of this paper has been devoted to the third objective. The authors have attempted to give a sound picture, both of the degree of perfection which can reasonably be expected from such a programme and of the magnitude of the time and effort which must go into its preparation and use. G. W. T.

335. A different kind of bundle cleaner. Anon. *Oil Gas J.*, 27.10.58, **43** (56), 84.—A new jetting tool is described for cleaning heat-exchanger tube bundles which removes many deposits which could not be removed satisfactorily by other methods. Various jet heads are used to deliver 65 gal/min to 175 gal/min at 3000 psi. The cleaner consists of a hydraulic jetting head fastened to a movable beam extending two bases. The jet head is mounted on a trolley motor propelled along the supporting channel beam. G. A. C.

ABSORPTION AND ADSORPTION

336. Nomogram for tower packing height. Liang-Tsen Fan. *Petrol. Refin.*, 1958, **37** (9), 346.—Capacities of packed absorption towers, both commercial and pilot plant scales, are often represented by the overall mass transfer coeff (K_GA), which is calculated for the following equation:

$$K_GA = \frac{N}{\dfrac{h\Delta P_2 - \Delta P_1}{\ln \dfrac{\Delta P_2}{\Delta P_1}}}$$

where N = rate of absorption in lb mol per (hr) (sq. ft.); h = height of packing, ft; P_2 = driving force at bottom of tower packing; P_1 = driving force at top of tower packing. Based on the above equation, a nomogram is presented and its use is illustrated by an example. M. F. M.

337. Adsorption process now practical for recovery of natural gas liquids. W. M. Dow. *Oil Gas J.*, 3.11.58, **56** (44), 74.—A field processing method is given for treating relatively small or lean gas streams using a dry extraction process. The combination LPG and gasoline recovery unit has four adsorbing towers, both silica gel and activated carbon being adsorbents. Tables show performances of actual adsorption installations for various-sized towers, economies of the process, and comparative recoveries for moderately rich and very lean gas condensate fields. G. A. C.

SOLVENT EXTRACTION AND DEWAXING

338. Use graph to design for optimum economic extraction. R. S. Olson. *Chem. Engng*, 1958, **65** (20), 143–5.—Solvent extraction is often set up as a counter-current, multi-stage operation. The effectiveness of this operation is fixed by feed rate, distribution coeff, and the number of theoretical stages required. Optimum operating conditions can be obtained by calculating the efficiency at several values of the operating variables, but this is a long, tedious, and time-consuming procedure. In this paper, a chart is provided which correlates the optimum number of stages, the extraction factor, and recovery. Although this chart is designed for linear distributions, it may be used with some accuracy on systems which are only moderately linear.

Two examples, the first on counter-current decantation and the second on solvent extraction, are given in the paper as a guide to the use of the chart and in helping the reader to solve more complex problems. M. F. M.

CRACKING

339. Hydrogenating cracking of petroleum residues. (In German.) D. H. Stevenson and H. Heinemann. *Brennst-Chemie*, 1957, **38** (15–16), 243–6.—A process is described for hydrogenating cracking of petroleum residues at 250 atm pressure. Continuous working at this pressure for extended periods is made possible by using a light hydrocarbon, *e.g.* butane, as diluent in the introduced material. Excellent yields of light and medium dist are obtained with definite cat; H_2 consumption is relatively low. Co–Mo–oxide cat on Al_2O_3 is the best for this purpose. The resulting gasoline is suitable for cat reforming; the synthetic gas oils resemble fresh gas oils and are cracked easily. From an economical viewpoint relatively high installation costs and normal amortization time result. If the requirement for different products changes, the process can be also economically attractive. 10 refs. R. T.

340. The thermal cracking of *n*-hexadecane as a homogeneous step-by-step reaction of the first order conducted in stream. (In Russian.) G. M. Panchenkov and V. Ya. Baranov. *Khim. i Tekh. Topliva i Masel*, 1958, (9), 24–8.—If the rate of thermal cracking of *n*-hexadecane is judged according to the yield of 285° final b. p. fraction, then this reaction can be regarded as a step-by-step reaction:

$$A \xrightarrow{k_1} v_1A_1 + V_2A_2 + V_3A_3 \xrightarrow{k_2} V_4A_1 + V_5A_2$$

Equations are derived for the yield of intermediate product and the rate constants for the first and second stages of the thermal cracking reaction. When the degree of conversion is less than 0·6 the equation of the first order step-by-step homogeneous reaction becomes an equation for a simple first order reaction flowing in stream. G. W. T.

341. Investigations on hydrocarbon cracking in the electric arc. (In German.) G. A. Fester, E. A. Martinuzzi, and A. I. A. Ricciardi. *Erdöl u. Kohle*, 1957, **10**, 840–2.—Experiments are described on liq hydrocarbon cracking—with the luminous arc below the liq surface—in the illustrated apparatus. In petroleum or diesel fuel oil cracking with Zn, Hg, or Pb cathodes higher C_2H_2 yields were obtained than with Fe, C, or Cu electrodes; intermediate yields were obtained with Al electrodes. R. T.

342. Production of olefinic gases by cracking hydrocarbons. (In German.) H. Pietsch. *Erdöl u. Kohle*, 1957, **10**, 837–40.—The known autothermic process for C_2H_6 and C_3H_8 hydrocarbon cracking to olefins is applied to light gasoline cracking. Conventional cracking of C_2H_6 with O_2 is very temp-sensitive. At 800° C the yield is 13 wt %; yields increase rapidly to max 60 wt % at 900° C. Light gasoline cracking shows a conversion degree comparable with tube pyrolysis. Olefin yield at one throughput is 20 wt %; this is increased by recirculation, whereby fixing of current operating conditions is determined by local processing possibilities. 8 refs. R. T.

343. Cat cracker sets challenges. C. H. Chilton. *Chem. Engng*, 1958, **65** (20), 120–3.—Tidewater Oil's giant Ortho-flow fluid cat cracking unit at Delaware with the design capacity of 102,000 b.d. stands as the largest such unit in the world. It consists of a single 200-ft high converter vessel which houses the reactor and cat regenerator. The 60-ft dia regenerator is mounted on top of the reactor vessel which contains the cat stripper in its centre section. Max total weight is 9500 tons. To circulate and regenerate 85 tons/minute of cat an Ingersoll-Rand centrifugal blower with a capacity of 137,000 s.c.f.m. driven by an 11,250-h.p. turbine is used. To help good cat distribution two risers and four stand-pipes are used, together with a large number of oil inlets to the reactor (28, including those for recycle), to assure good contacting throughout reactor and regenerator. 16 cyclones in the reactor and 60 in the regenerator separate the entrained cat. Feed used is a mixture of virgin and fluid coker gas oils and the cat bed temp is maintained at *ca* 900° F. M. F. M.

ALKYLATION

344. Alkylation—what you should know about this process. R. E. Payne. *Petrol. Refin.*, 1958, **37** (9), 316–29.—This comprehensive article describes the many factors which influenced the alkylation process and its products. Detailed descriptions and flow diagrams of sulphuric acid and hydrofluoric acid alkylation processes are given, and a summary of U.S. alkylation capacity, in tabulated form, is included.

The products of hydrofluoric and sulphuric acid alkylation differ somewhat because the plants are operated at different conditions. The more important variables affecting the product quality are *iso*butane concn, olefin space velocity, reaction temp, cat strength, olefin injection, and mixing. These are all considered in detail.

The economics of hydrofluoric and sulphuric acid alkylation methods are compared. Since this shows that the two methods are economically close in most cases, plant selection is often based on the availability of each cat and the ultimate octane requirement. M. F. M.

345. Free radical alkylation of *iso*butane with ethylene. J. A. Ridgway, Jr. *Industr. Engng Chem.*, 1958, **50** (10), 1531–6.—Present processes for the free radical alkylation of *iso*butane with ethylene produce neohexane in much less than the theoretical yield. To improve yield, reaction conditions have been studied and a search for effective reaction modifiers has been undertaken. Temp was the principal variable considered: yields improved with increasing temp to an estimated 40% theoretical at 750° F. Little advantage was indicated for higher temp.

Of the potential modifiers studied, only the halogens were effective. The best of these was ethyl bromide. The 40% estimated yield of the unmodified process was increased to over 70% by the addition of 0·4 mol % ethyl bromide on ethylene charged. M. F. M.

346. Recent advances in alkylation with sulphuric acid. (In German.) P. W. Sherwood. *Erdöl u. Kohle*, 1957, **10**, 853–6.—A sudden new swing of alkylation is caused by the rapid rise in motor gasoline O.N., whereby premium fuels already approach the O.N. range of aviation gasolines. Means for raising O.N. are max TEL addition, intensified cat cracking, broadening and intensification of reforming, and alkylate introduction. Polymerization and alkylation for converting C_3- and C_4-hydrocarbons into strongly branched, *i.e.* knockproof, mol in the gasoline boiling range are compared. Advantages and disadvantages of H_2SO_4 and HF

cat and methods for alkylation acid disposal are discussed. Reactor types, effects of operating variables, *e.g.* temp, are discussed. R. T.

347. Propylene successfully alkylated. L. Resen. *Oil Gas J.*, 24.11.58, **56** (47), 73.—High quality alkylate in HF alkylation units using propylene as feed has been made in trial run at Phillips Petroleum Co., Sweeny, Texas, refinery, by making changes in unit to take advantage of thermal defluorination. Changes included installation of new feed heater, addition of large bundle to reboiler, doubling of condenser surface, and replacement of bubble-cap with valve type trays. Flow sheet is given, and tables give yields and product inspections. G. A. C.

ISOMERIZATION

348. Iso-Kel, a new isomerization process. (In German.) Anon. *Erdöl u. Kohle*, 1957, **10**, 851–2.—Improvement in octane quality of straight-run naphthas and natural gasolines by isomerization of pentanes and hexanes in one operation is described. Activity and selectivity of the precious-metal cat (not Pt), is so high that C_5H_{12} and C_6H_{14} are isomerized together without any detrimental reciprocal action, *n*-hexane conversion being *ca* 75% and *n*-pentane *ca* 60%. The process can be conducted to give two different products, *iso*pentane O.N. (research) 104·0, and *iso*-hexane O.N. (research) 89–93·5, depending on the nature of the charged material. In processing light naphtha the reaction products together give a fuel of *ca* 96 O.N. (research) with 98 vol % yield. The product from natural gasoline has O.N. (research) 99·6 with 99 vol % yield. R. T.

CHEMICAL AND PHYSICAL REFINING

349. Hot potash process. J. H. Crow and J. R. Dijngan. *Oil Gas J.*, 24.11.58, **56** (47), 97.—Use is described of hot potash process in 100 million cu. ft/day natural gas treating plant of Lone Star Producing Co. plant at Fashing, Texas. Acid gases are removed by the scrubbing process with hot K_2CO_3 soln, final purification is achieved by aq M.E.A. Recovered acid gas is flared. Potash soln is regenerated by steam stripping, and M.E.A. is re-distilled. Flow sheets of potash system and M.E.A. purification plant are given. G. A. C.

SPECIAL PROCESSES

350. Experience of desulphurization and refining of visbreaking gasolines. N. Malle and S. Sirtori. *Riv. Combust.*, 1958, **12** (10), 746–62.—To obviate the difficulties encountered in the conventional refining of visbreaking gasolines, an attempt has been made to develop a more reliable, less costly process, the products of which can easily be used in blends with gasolines from other sources. A cat refining process to heat these gasolines with attapulgite earths in two stages is described. The product obtained has a higher O.N., lower sulphur content, is non-corrosive for metals, has a pleasant odour, is more susceptible to TEL, has a low diolefin content, and lends itself well to blending with other gasolines.

(Authors' abstract.)

351. Desulphuration of gasoline with natural catalysts (Yugoslav bauxites). D. Gjurgjevic and R. Lipovscak. *Nafta* (*Yugoslavia*), 1958, **9** (9), 255–60.—In the article all data concerning the testing of the desulphuration of the primary Iraq gasoline with natural cat of Yugoslav origin are given. From two tested samples of bauxite (Pula and Lozovac) the sample from Pula has proved better, being more selective in a wider temp range. Considerably longer duration and better effect of the desulphuration of the bauxite from Pula is attributed to the greater surface activity which is narrowly connected with its microcrystalline structure. The reduction of sulphur amounts to 88–95%; the yield of gasoline at a temp range of 360°–410° C and a max space velocity of 6·4 vol/vol/hr amounts to 98% by wt. The antiknock properties are improved for 3–4 units as compared with the basic gasoline and with 1 ml TEL/kg a value of 76 O.N. is obtained.

(Authors' abstract.)

METERING AND CONTROL

352. Electronic remote measurements and their application in the petroleum industry. P. Ouvrard. *Bull. Ass. franç. Tech. Pétrole*, 1958, 445–77.—Charles Bihoreau prize lecture, 1958. Brief discussion of general requirements and of electronic transmission principles; impulse generators (single- and two-channel) and corresponding receivers; methods of transmission, wire, radio, carrier currents; numerous circuit diagrams and illustrations. V. B.

PRODUCTS

CHEMISTRY AND PHYSICS

353. Behaviour of hydrocarbon oils in the electrical field of force. (In German.) M. Freund and G. Földiák. *Erdöl u. Kohle*, 1957, **10**, 758–61.—Investigations are discussed on changes which different transformer, lubrication, and white oil products undergo as dielectrics in a cyl-condenser test apparatus under 6–10 kV voltage and 500–1000 c.p.s. frequency. In most cases parallel reactions of gas absorption and evolution take place. Paraffin hydrocarbons evolve H_2-rich gases in the electric field of force; aromatic hydrocarbons absorb H_2 from the gases. Naphthenes can, by ring splitting, also absorb H_2, but dehydration reactions must be considered. Reactions in the electric field of force seem to take place chiefly at the gas and oil phase boundary, also mainly in the oil film adhering to the glass walls of the apparatus; consequently, the reaction velocity depends on the prevailing gas pressure, but also on the current voltage and frequency. The importance of resistance to gas development of insulating oils in the electric field of force is indicated and a method for testing it proposed. 21 refs. R. T.

354. Carbon index of fuel gases and its practical application. C. Padovani and E. Caffo. *Riv. Combust.*, 1958, **12** (10), 725–45.—The carbon index (vol of carbon dioxide produced by complete combustion of 1 vol of gas) is a typical characteristic of fuel gases that can be relatively easily assayed experimentally. There is a correlation between the mean carbon index and some chemical and physical properties of gaseous hydrocarbon mixtures. The correlation is approx (generally with a very slight error) for the cal. val. and relative density; for theoretical air and theoretical combustion fumes the correlation is exact. The hydrocarbons considered were the gaseous hydrocarbons of the methane and ethylene series.

In particular, it is shown that the carbon index may be usefully employed to determine the correction coeff due to the presence of the higher hydrocarbons, which Delbouy has introduced into his latest interchangeability formulæ to correct the Wobbe index and combustion potential.

In these cases, as well as for calculating the soot index of ventilated or non-ventilated flames, computation on the basis of the carbon index may be found not only easier, but notably

more precise than the exact or approx methods proposed by Delbouy. (Authors' abstract.)

ANALYSIS AND TESTING

355. Structural analysis of hydrocarbon polymers. II. (In German.) C. Boelhouwer *et al.* *BrennstChemie*, 1957, **38** (15–16), 241–2.—Physical const of polymerized non-cyclic hydrocarbons are summarized to show that the modified method given in Pt I is applicable for the structural analysis of the strongly branched products propene and *n*-butane-1. Results of the direct method for estimating ring cont—on the basis of elementary analysis and mol. wt. of the hydrogenated material—are compared with those developed for characterization of mineral oil fractions. Resulting from the high branching degree of the polymers, use of ring analysis and *n–d–M* method leads to strongly deviating results. A recently improved modification of the original ring analysis, in which the branching degree is considered, permits rational estimation of the average ring No./mol of the polymers—in agreement with the results of the elementary analysis—and an approx estimation of the branching degree. 9 refs. R. T.

356. Flame photometric estimation of lead tetraethyl in carburetter power fuels. (In German.) W. Linné and H. D. Wülfken. *Erdöl u. Kohle*, 1957, **10**, 757–8.—An improved method is described which utilizes the fact that the radiation intensity at 402·0 mμ corresponds to the flame background intensity of the sample to be tested. An additional amount of TEL (generally 0·03 vol %) is mixed with this sample and the radiation intensity determined at 405·8 mμ. Three readings are obtained: radiation intensity of the sample at 405·8 mμ, of the sample at 402·0 mμ, and of the sample + known quantity of TEL at 405·8 mμ. The required TEL concn is calc from equation: $\text{TEL [vol \%]} = \frac{(a-b)}{(d-a)} \cdot c$, where a = scale divisions on the indicating instrument for sample at 405·8 mμ, b = the reading for sample at 402·0 mμ, c = vol % TEL added to the sample, d = scale divisions on indicating instrument + additional TEL quantity at 405·8 mμ. R. T.

357. Extending the fluorescence indicator adsorption method (FIA) for detecting the four main hydrocarbon groups of gasolines. (In German.) K. Schindel. *Erdöl u. Kohle*, 1957, **10**, 754–7.—In conventional use of the FIA method analysis ended with measurement of the vol proportion of the three hydrocarbon groups, aromatics, olefins. By the extended method, not only aromatics and olefins, but also paraffins can be determined separately in samples of a few cm. In the paraffin and naphthene estimation accuracy is approx 5%, constituting a + in paraffin cont and a − in naphthene cont. Tabulated results comparing PONA and FIA figures show in primary gasoline approx equal errors, but more favourable results with gasoline produced by cracking. The method has proved useful for rapid orientation on the structural composition of gasolines or gasoline fractions. R. T.

358. Advances of Raman analysis by developing photoelectric recording procedure. (In German.) E. Preuss and H. Luther. *Erdöl u. Kohle*, 1957, **10**, 761–5.—Following a general review of the experimental foundations and application possibilities of Raman spectroscopy, a process for self-recording of Raman spectra is described. The efficiency of the method is shown by an example on the combined i.r. and Raman analysis of a platformer gasoline sample. A quant Raman analysis after a qual i.r. analysis gives a result very rapidly, which agrees well with the expected figure. 24 refs. R. T.

359. Measurement of the air content of hydraulic oils and similar fluids. D. Firth and J. Kane. *Engineer, Lond.*, 1958, **206**, 679–80.—New device for measuring gas content of oil consists of cyl chamber containing cage filled with steel balls and rollers, to which is attached removable sample container with weight-loaded valve, and connexions to vac pump and McLeod gauge. After evacuation of apparatus to 0·005 mm Hg vac, pump is disconnected and chamber is inverted. This opens weight-loaded valve, which allows oil in sample container to explode into chamber; resultant spray settles on to balls and rollers to expose large thin film interface between oil and vac. Vol of gas released is calc from increase in pressure observed, using correction for v.p. of oil if latter is appreciable. A. C.

GAS

360. The outlook for automation in gas transmission systems. A. L. Vaughan. *Pipe Line News*, 1958, **30** (11), 65–70.—Automation should be regarded as an extension of the great industrial revolution which began in the latter half of the nineteenth century. It will not replace man in industry, but it will require a higher degree of education or training for the workers. The application of automation to gas transmission has been highly successful, both from the economic and the operational standpoint.

Description is given of the successful operation of five gas transmission stations belonging to Northern Natural Gas Co. which are "push button controlled." These stations use gas turbines as well as reciprocating compressor engines. Control equipment on each engine is designed to allow the operator to start and operate the machine manually should the automatic control system fail. Enough experience has been accumulated to indicate that automation is reliable and successful.

One of the areas where great progress can be made towards automation is in working and co-operating with the engine manufacturers in order to simplify the equipment, particularly the control and check points. Standardization of equipment is another area in which progress can be made towards reducing the cost of automation. The components of automatic control can be electrical, pneumatic, or hydraulic. The best results are obtained when a combination of all three methods is used, each in its most advantageous application. M. F. M.

361. Natural gas liquids: refrigerated propane bulk-storage. C. I. Kelly. *Petrol. Times*, 5.12.58, **62** (1600), 969.—The refrigerated propane storage plant occupying 113 acres at the plant of Atlantic Gas Light Co., Riverdale, Georgia, is described. The insulated storage tank holds 1,078,000 I.G. at −46° F and 0·5 p.s.i. pressure. Foam-glass insulation in two layers was used. Tank filling is arranged through two conventional pressure storage tanks and a reducing valve which reduces pressure from 100 lb to *ca* 0·5 lb; thus in flash-vaporizing the propane becomes its own refrigerant. Adequate precautions against fire and in case of refrigeration failure are taken. The plant adds 50 million cu. ft/day to existing peak load facilities of 100 million cu. ft/day. Economics are briefly described. G. A. C.

362. Coal, oil, and underground reservoir as foundations of gas provision of a large town. (In German.) G. Düwel. *Erdöl u. Kohle*, 1957, **10**, 843–51.—Economical conditions for gas supply are explained—with numerous diagrams and photographs—by the example of gas provision for a large town. Operational connexions of refinery gas and petroleum gas cracking installations, also underground storage, are explained. Tech production possibilities and gas use for heating purposes, and their impact on living standards are disclosed. 7 refs. R. T.

363. Fluid bed desulphurizes fuel gas. Anon. *Chem. Engng*, 1958, **65** (21), 74.—Description and the flow diagram of Appleby–Frodingham Steel Co.'s pilot plant for desulphurizatien of fuel gas for open hearth furances are given. The process uses dual fluid beds of iron oxide to desulphurize coke-oven gas containing approx 1·0% H_2S and 1% organic sulphur. The sulphided iron oxide undergoes regeneration many hundreds of times and still retains its useful activity.

M. F. M.

ENGINE FUELS

364. The vapour pressure tolerance of fuel systems. L. E. Hebl. *SAE Paper* No. 104B, 1958.—This paper presents a technique where the volatility tolerance of a given car is expressed in terms of a constant *C*, which is equiv to a F temp number. Using liquid temp, all pure cpds give a value of *C* approx equal to 234. The value of *C* for automotive fuel systems is usually lower than 234 when atm temp is used in place of liq temp. The vapour pressure tolerated by a given fuel system also depends upon the vapour handling bonus which responds to a combination of an equipment design constant and to the dist slope of the fuel. Test fuels which differ in the latter respect are required in determining the vapour handling constant *V*. With different cars the value of *V* usually falls between *ca* 1·0 and 10·0. When the vapour handling constant *V* is unknown, the use of a median value of 5 introduces a relatively small error in most cases.

G. W. T.

365. If you squeeze them, must they scream? W. M. Wiese. *SAE Paper* No. 61J, 1958.—These investigations were concerned with the influence of the following factors on the O.N. requirement and the occurrence of surface ignition in high-compression automobile engines: (1) a change in gasoline tail-end volatility; (2) a change in gasoline aromatic content; and (3) the use of various ignition control additives in the gasoline. Approx 300,000 miles of deposit accumulation driving and testing were done using eight cars having experimental engines with measured clean C.R. of 10:25:1.

G. W. T.

336. Engine pounding—its causes and control. J. H. Bame and R. G. Tuell. *SAE Paper* No. 61G, 1958.—This paper is a study of rumble or pounding, with particular emphasis on the mechanism involved, the present and potential future extent of the problem, and means whereby the noise can be controlled or eliminated. Observations were made on many of the 1958 model cars and, based on tests conducted in experimental high compression engines, it is supposed that the problem worsens as C.R. are increased. The use of *tri*cresyl phosphate in the deposit fuel has indicated the most effective way to control this problem up to date in current and earlier car models. However, in more severe 11 and 12:1 C.R. engines, pounding and other surface ignition effects are only partially overcome, and it would appear that unless assistance is forthcoming from the viewpoint of engine design, other effective means may have to be discovered for controlling surface ignition in these engines. G. W. T.

367. Investigating rumble in single-cylinder engines. J. A. Robinson *et al*. *SAE Paper* No. 61H, 1958.—In this investigation, emphasis was placed on studying the causes of the high rates of pressure rise. It is believed that this is a more fundamental approach than studying audible manifestations of high rates of pressure rise which might occur in many ways. In order to clearly define the combustion phenomena leading to rumble, flame propagation in a single cyl engine during normal combustion and rumble was measured by multiple ionization gaps. G. W. T.

368. Comparison of the efficacy of additives for preventing the precipitation of lead sediment from ethylated motor fuels. (In Russian.) A. L. Gol'dshtein *et al*. *Khim. i Tekh. Topliva i Masel*, 1958, (9), 35–7.—The effect of 2,6-*di*tertiary butyl-4-methylphenol (BMF) on the stability of various aviation gasolines has been studied. A concn of 0·004% BMF gave good stability for the majority of gasolines. Its efficiency in preventing deposition of lead sediment was inferior to *para*-oxydiphenylamine at this concn. A blend of the two additives was more efficient as an anti-oxidant than either separately. G. W. T.

369. The breakdown of cadmium coatings exposed to fuels with increased mercaptan content, and the methods for its prevention. (In Russian.) B. A. Englin *et al*. *Khim. i Tekh. Topliva i Masel*, 1958, (9), 38–42.—This breakdown is aggravated when the content of aliphatic mercaptans and of dissolved water is increased. It has been suggested that this may be prevented by using a mixture containing amine vat residues boiling above 100°. These residues are formed during the synthesis of low mol. wt. aliphatic amines.

G. W. T.

370. A new manganese antiknock. J. E. Brown and W. G. Lovell. *Industr. Engng Chem.*, 1958, **50** (10), 1547–50.—*cyclo*Pentadienyl manganese tricarbonyl and its methyl derivative are the most effective of a group of manganese coordination cpds recently evaluated for antiknock action. In unleaded fuels, they are about twice as effective as TEL, and they compare even more favourably when employed at small concn in leaded fuels.

These cpds are promising as practical additives which can successfully compete with refining methods for high octane fuels. Because of its physical properties, the methyl derivative is most suitable for fuel use, and most of the data have been accumulated for this rather than the parent structure. Process-development studies through the pilot-plant stage indicate that both cpds can be made on a commercial scale at a reasonable cost. M. F. M.

371. Combating carburettor evaporation losses. Anon. *Fuel Effic.*, May 1958, **6** (5), 28–31.—This presents some results obtained by General Motors Corpn in a study to measure the amount of fuel lost through the external float bowl vents of different carburettors. Five test cars were used with fuels of different R.v.p. One car, with a four-barrel carburettor which had many internal vents and one small external vent, showed no loss under driving conditions, whereas the other four did. However, this car showed considerable loss when subjected to hot idling tests. The author suggests two ways to combat loss; (1) change the fuel system so that it can meter the correct amount of fuel regardless of volatility; (2) reduce fuel volatility. Analysis of volatile hydrocarbons had shown them that these losses caused air pollution, as well as aggravating the problems of fuel economy and hot weather idling.

E. M. I.

372. Engine research with nitroparaffins. E. S. Starkman. *Petrol. Times*, 5.12.58, **62** (1600), 977.—Extracts are given from a paper presented to the A.C.S., April 1958. The research was carried out on fuels which carry part of their own oxygen into the combustion process, to provide hypothesis and data regarding charge density and chemical character of the fuel. The most important fuel characteristic of the nitroparaffins is associated with the oxygen bonded into their structures, and another important factor relates to the composition of the products of combustion. Engine application considerations include tendency to induce pre-ignition. Some experimental data are given, and it is stated that nitroparaffins do speed up total reaction; the data relate only to spark ignition engines, but may equally be applicable to diesels.

G. A. C.

373. Colloidal coal in diesel fuel. Anon. *Mech. Engng*, Sept. 1958, **80** (9), 75.—Experiments are being carried out by the Denver and Rio Grande Western Railroad on the use of irradiated colloidal coal suspensions in diesel fuel to lower cost. Effect of radiation is to reduce particle size of coal to same order as petroleum fuel. Work on dosage, geometry of fuel, storage type of radiation and cat, and coal combustion is still going on. An engine has run satisfactorily except for a small rise in temp of cooling water. E. M. I.

374. Diesel fuels—confusion compounded—why? G. K. Brower and W. Lenzi. *SAE Paper* No. 74A, 1958.—This paper briefly presents the background of diesel fuel classifications; the apparent causes for the "compounded confusion" now existent with regard to these fuels; the characteristics of fuels currently available; a review of diesel fuel specifications as published by the major consumers and engine manufacturers; data concerning related fuel types; and proposals for the promulgation of a commercially realistic diesel fuel classification agreeable to the petroleum industry, the consumer, and the engine manufacturer. G. W. T.

375. Low-temperature diesel fuel trials. Anon. *Inst. Petrol. Rev.*, 1958, **12** (143), 387.—This outlines the conclusions of winter tests by Esso engineers. They found that simple changes in the design of the fuel system, such as larger bore fuel lines with smooth bends and use of plastics for fuel pipes, prevent formation of wax crystals in the fuel and allow vehicles to be operated at temp as low as its pour point. E. M. I.

376. Use of petroleum products for rocket fuels. Anon. *Petrol. Times*, 5.12.58, **62** (1600), 972.—This is a translation of an article by A. Bilderling, on "propergols" (fuels for rockets), which are made up of an association of at least two compounds, fuel and oxidizer, which react to give gas. Most propergolic combinations do not allow priming and have to be separately injected into the combustion chamber. Propergols must possess high specific impulse and as high a density as possible, contradictorily they should have low mol. wt. and low vapour pressure, low freezing point, and rapid ignition. They should store well for a considerable time. Principal combinations in which kerosine is the fuel are tabulated. Other combinations are being studied. G. A. C.

GAS OIL AND FUEL OIL

377. Avoiding smoke from an oil-fired plant. Anon. *Fuel Effic.*, April 1958, **6** (4), 40–1.—This describes the fitting of sealing units to two oil-fired Lancashire boilers to prevent smoke emission during low load running periods. They also cause reduced fuel consumption during low load periods and increase the efficiency of the plant. E. M. I.

378. The efficient generation of steam. R. D. Hoskin. *Fuel Effic.*, May 1958, **6** (5), 14–17.—For efficient boiler operation care must be taken to choose the correct fuel with respect to their basic heat values, cost, and probable efficiency in application. A chart comparing coal, fuel oil, and gas for cost, availability, cleanliness, etc., is given. Other important factors are correct fuel/air ratio, elimination of leakages, secondary air intake, automatic stoking, reclamation of "waste heat," control of boiler feed water, good lagging, boiler cleanliness and control, steam pressure regulation, and the employment of good operators. E. M. I.

LUBRICANTS

379. Lubrication in the nuclear age. C. G. Williams. *Inst. Petrol. Rev.*, 1958, **12** (143), 365–7.—A summary of the paper read to the British Association. It deals with the effect of nuclear radiation on hydrocarbon oils, greases, and synthetic lubricants. E. M. I.

380. Machine tool slideways and lubrication. T. M. Birchall and A. I. W. Moore. *Mech. World*, 1958, **138** (3473), 558–63.—A summary of investigations carried out at PERA to provide design data for the slideways of machine tools. It includes a study of the effect of lubricant visc and load on the lubrication conditions occurring between flat plates under parallel sliding conditions. Straight mineral oils containing no boundary additives and with visc of 100,500 and 1500 Redwood I sec at 70° F were used. E. M. I.

381. A theory of lubrication in short journal bearings with turbulent flow. L. M. Tao. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (8), 1734–40.—A study of bearing characteristics during turbulent motion of the lubricant, especially the pressure distribution and the load capacity and altitude relationship. A comparision is made with conditions of laminar flow. 16 refs. E. M. I.

382. Diesel engine lubrication findings. E. Jann. *Schweiz. Arch. angew. Wiss.*, 1958, **24**, 319–25.—Previous conclusions (*cf* Abs. **263**, 1957) on effect of lubricant alkalinity on engine condition are summarized and results given on 2000-hr test in 8-cyl 600-h.p. 4-stroke diesel under full load (600 rev/min) using a Caterpillar series 3 oil (Shell Rimula 20). Trials in 2-stroke marine engines indicate that to maintain engine port cleanliness Ca-based additives are better than Ba. Tests on an 8-cyl 2-stroke engine showed that use of an emulsified oil (Shell Alexia A) as cyl lubricant gave low exhaust port fouling. Valuable guidance as to oil condition and time for oil change can be derived, by experienced observers, from an oil spot test (*cf* Abs. **539**, 1957), and description of Shell ADC oilprint analysis method, with coloured reproduction and discussion of results on 12 samples, is given. Test will indicate excessive soot in oil, insufficient alkaline reserve, presence of water, and excess fuel dilution. V. B.

383. Advances in lubrication. (In German.) A. Foulon. *Schmiertechnik*, 1958, **5**, 227–9.—This is a review of advances in lubricants and lubrication. Among other things, it deals with: solid lubricants, such as molybdenum and tungsten *di*sulphides; E.P. lubricants containing *poly*oxyalkylenes and the thermal condensation product of an aliphatic oxycarboxylic acid and an aliphatic polyvalent alcohol; orthophosphates with quaternary ammonium cations for boundary lubrication; and lubricants that can withstand a large variation in temp. G. W. T.

384. Bearings, lubricants, and lubrication. *Mech. Engng*, Sept. 1958, **80** (9), 64–74.—A digest of 1957 literature covering boundary lubrication, metal working lubrication, automotive lubricants, properties of lubricants, bearings, and gear lubrication, with a bibliography of 208 literature refs, four books, and eight OTS research reports. E. M. I.

385. SAE motor oil classification. M. Brunner. *Schweiz. Arch. angew. Wiss.*, 1958, **24**, 305–8.—General discussion; attention is drawn to errors arising in case of non-Newtonian polymer-containing oils from permitted extrapolation to 0° F of visc determined at higher temp. Diagram is given on which SAE ranges are graphically depicted on basis of visc/50° C (11–300 cS) and V.I. (20–150). V. B.

386. Progress in wire drawing. Anon. *Mech. World*, 1958, **138** (3472), 498–504.—A review on recent improvements in the technique of wire drawing in which the problem of die lubrication is discussed. BISRA's investigation has shown present methods to be unsatisfactory because of excessive die-wear and difficulty of removing lubricant from wire. They also show lime has no useful purpose in lubrication and

that stearic acid is more effective than calcium stearate. Drawing of Cu wire is discussed and high-speed drawing with soap emulsions suggested. Wear in high-speed drawing, it is suggested, could be reduced if oil is supplied to the entry of the die at a pressure comparable to the yield stress of the wire. Die construction, diamond dies, drawing speeds, drawing machines, and heat treatment are other topics discussed.
E. M. I.

387. Representation of temperature dependence of oil viscosities by the method of true exponents. (In German.) L. Andrussow. *Erdöl u. Kohle*, 1957, **10**, 856–60.—Transport phenomena of highly-compressed gases, also visc and diffusion in the liq phase can be grasped simply as regards temp and pressure dependence by analysis of true and medium exponents. The method is applied to the characterization of the temp dependence of visc of highly-viscous oils. 24 refs.
R. T.

388. Aviation turbine oils. (In German.) H. G. Krischai. *Erdöl u. Kohle*, 1957, **10**, 862–6.—Aviation turbine development and lubrication are held in close relationship to requirements of military aviation. Special properties of oils for sp purposes, *e.g.* volatility, oxidn stability, behaviour at low temp, etc., are discussed and satisfactory oils suggested. Rubber seals on contact with the oil must not swell and become porous. Jet engines make small demands on the oils, highly-fluid mineral oils to military spec are satisfactory. Certain esters of long-chain dicarboxylic acids and branched alcohols were used successfully in Germany during the war. Testing methods and future turbine requirements are discussed.
R. T.

389. The relationship between the properties of silica gels and the behaviour of silica greases. Pt 2. (In German.) G. R. Schultze *et al. Schmiertechnik*, 1958, **5**, 223–7.—The consistency–temp relationship of silica gel greases is largely determined by the surface impurities in the gels. Careful drying has no effect on the thickening capacity, but if a thermal strain is imposed, this capacity alters as a result of secondary reactions. Storage properties are also affected by surface impurities in the gels. The variable behaviour of the gels can be related to the chemical constitution of these hydrophobic cpds.
G. W. T.

390. Laboratory oil tests predict field performance of lubricating oils. J. A. Miller *et al. SAE Paper* No. 57D, 1958.—This paper presents the correlation between piston varnish in the CRC FL-2 test, " Research Technique for Determining Effects of Fuels and or Lubricants of Formation of Engine Deposits during Moderate Operation," and deposits in passenger car engines in city traffic driving. The correlation was obtained by increasing the severity of the FL-2 test through the use of a special reference gasoline that formed heavy piston varnish with conventionally compounded motor oils of MIL-L-2104A level. Thus, it was possible to recognize improvements in lub oil detergency in a short-term lab engine test. Data from over 6 million miles of field testing and over 800 FL-2 tests were analysed to prepare this correlation.
G. W. T.

391. The influence of alkali on the oxidation of lubricating oils. K. U. Ingold and I. E. Puddington. *J. Inst. Petrol.*, 1958, **44** (414), 168–77.—Kinetic measurements on the rate of oxygen uptake of a normal SAE 30 oil and after adding (1% NaOH) are described. The oxidized oils were then tested for transparency, pH, Acid No., and visc. Normal oxidn caused dark oils with a low pH value, whereas in presence of NaOH, the pH value was at a minimum around 2 cc O_2 and transparency increased.

Alkali addition was shown to decrease sludge and varnish formation, this being illustrated by photomicrographs of filtered used SAE 10 oil after alkaline oxidn for 24 hr.

An i.r. study showed normal oxidn to produce acids, ketones, esters, small amounts of alcohols and lactones and traces of anhydrides, and an oil insoluble sludge, due probably to esterification reactions involving di-functional oxidn products, mainly hydroxy acids. The alkali addition caused neutralization of the carboxylic acids and prevented formation of esters, which are a main part of the sludge; the bleaching action suggested oxygen attack at or near many conjugated bonds seen to be present in normal oxidized oil. Various other speculations are made from the data obtained.
E. M. I.

392. Lubricants for nuclear reactor systems. L. W. Manley *et al. SAE Paper* No. 53B, 1958.—This paper is concerned with an effort to establish the requirements for radiation-resistant lubricants in a nuclear power or propulsion system in relation to the technology that can be developed for radiation damage encountered with conventional and experimental products. Exposures were made by means of a Van de Graaf Accelerator, gamma protons from a Cobalt 60, and mixed neutrons and gamma particles from a nuclear reactor. Results indicated that radiation damage to lub oil base stocks and finished products involved visc change, loss of oxidn stability, and development of corrosive tendencies. Dynamic radiation testing appeared to be a more realistic method for evaluating lubricating performance under specific conditions of speed, load, dose rate, and temp.
G. W. T.

393. Lubricant additive action in combating low temperature wear in automotive engines. T. H. Randall *et al. SAE Paper* No. 107A, 1958.—This paper presents results of studies of the low temp wear phenomenon in a lab gasoline engine. The relationship between wear, jacket temp, and oil quality are amplified. The dependence of wear on available alkalinity and surface protection characteristics of a wide variety of lubricant additives is demonstrated. In addition, the effectiveness of surface protection is shown to be dependent on the type of acid mol encountered. The relative corrosivity of sulphur and halogen acids is illustrated, and the relative importance of alkalinity and surface protection characteristics of lubricants under extended service is discussed.
G. W. T.

394. Evaluation of anti-seizure and recovery-from-seizure properties of E.P. lubricants by the 4-ball testing machine. C. Paleari, A. Girelli, and C. Siniramed. *J. Inst. Petrol.*, 1958, **44** (414), 178–81.—The minimum seizing load is first determined, then a further nine runs made under loads increasing from this value. The mean of $\frac{LDh}{x}$ values for these runs represents the " E.P. Index No.," which indicates recovery from seizure properties. (L = applied load, Dh = Hertz line dia in mm, x = measured dia in mm). Several additives of different composition (compounds of S, Cl, P, and Pb) were added to the same base oil, their properties evaluated by this method and tabulated. Results proved that the minimum seizing load could only be determined with no additive present and that the additives became effective at a certain temp dependent upon their chemical stability. Sulphur showed the best E.P. properties, but when tested for corrosivity gave a high result.
E. M. I.

BITUMEN, ASPHALT, AND TAR

395. The influence of maltenes on the structure and properties of bitumen. A. Rio and M. Cerrone. *Riv. Combust.*, 1958, **12** (10), 763–72.—Continuing an investigation commenced some time ago, maltenes obtained from natural bitumens and petroleum are examined. A study is made of the influence they appear to have on the structure and properties of bitumens containing them, and attention is also turned to the way in which these properties are affected by the changes

wrought in maltenes by oxidative and polymerizing phenomena. (Authors' abstract.)

SPECIAL HYDROCARBON PRODUCTS

396. Liquid paraffin as a cause of oil aspiration pneumonia. G. Forbes and A. Bradley. *Brit. med. J.*, 1958, *ii*, 1566–8.—Brief literature review; description of pathological changes; histories of four fatal cases (oil aspiration pneumonia contributory cause of death in two, incidental in two) with detailed account of necropsy findings (photomicrographs of lung sections). Mineral oils were distinguished from fatty by inability of the former to reduce OsO_4. Liq paraffin strongly contra-indicated for nasal or oral sprays, since if it enters lung it may remain permanently; use as laxative requires reappraisal. V. B.

397. Solid petroleum hydrocarbons and their effect on wax properties. R. T. Edwards. *Tappi*, 1958, **41**, 267–74.—Petroleum waxes are composed of the solid non-aromatic hydrocarbons of petroleum. In the lower mol. wt. ranges, these consist entirely of normal paraffins. As the mol. wt. increases, other hydrocarbon types occur in greater amounts until, in microcrystalline waxes, cyclic hydrocarbons with long side chains are predominant. Properties of these waxes are dependent on the crystal lattice arrangement of the hydrocarbon molecules. Crystalline kinetics and lattice imperfections are of fundamental importance for the properties of petroleum waxes. The basic crystalline arrangement in these products is that of the *n*-paraffins, and the development of the crystal lattice is influenced by mol. wt. range and the presence of non-normal hydrocarbons. The mixture of solid hydrocarbons can be modified to produce waxes with a wide range of properties due to alterations in crystal growth. Details are given of the influence of these factors on the performance of petroleum waxes in standard tests and in service. G. W. T.

398. Methacrylate polymers as oil additives. C. J. Prizer. *Petroleum, Lond.*, 1958, **21** (11), 395–7.—Oil-soluble methacrylate polymers were first produced commercially during world war II and were used as V.I. improvers for hydraulic fluids. These polymers permitted the formulation of a single fluid which would serve over the entire range of temp encountered in the field operation of military aircraft. After the war methacrylate polymers were used as V.I. improvers and pour-point depressants for engine lubricants, and more recently a third property has been built into these polymers—the low temp sludge dispersancy. With this property it is possible to maintain engine cleanliness under adverse stop-and-go driving conditions.

The paper indicates, with the aid of graphs and pictures, the beneficial effect of methacrylate polymer additives on visc, pour point, and the low temp dispersancy of different types of oils, using a Chevrolet engine as test vehicle. M. F. M.

MISCELLANEOUS PRODUCTS

399. Production of detergents from olefins. (In Russian.) E. M. Khiefets *et al.* *Khim. i Tekh. Topliva i Masel*, 1958, (9), 48–54.—Detergents (secondary alkyl sulphates) may be obtained from olefins, which are formed in the synthesis products of CO and H_2 on various cat, in the dist from the thermal cracking of paraffins, and in the products of the dehydrogenation of paraffin hydrocarbons. Lab experiments on the sulphation of olefins have shown the optimum conditions to be: acid strength, 98%; M ratio, C_nH_{2n}; $H_2SO_4 = 1$; 1·5–1 : 2; reaction temp no higher than +10°. The greater the mol. wt. of the olefins, the less is the extent of the conversion. G. W. T.

400. Synthetic rubbers and the polyethylenes. E. G. Curphey. *Petrol. Times*, 7.11.58, **62** (1598), 901.—This is a review of the part played by petroleum fractions in the production of elastomers, and deals with production processes for ethylene butadiene, the dehydrogenation of the butenes, the purification of butadiene, and recovery of *iso*prene. Flow sheets are given. G. A. C.

CORROSION

401. Foundations of, and protection against corrosion. (In German.) W. Wiederholt. *Erdöl u. Kohle*, 1957, **10**, 773–7.—The latest knowledge of the fundamentals of corrosion and the corrosion process as discussed indicates the special importance of corrosion products. Thin, dense, strongly adhering layers generally have a passivating and corrosion-preventive action. Loose coatings of corrosion products, on the contrary, lead to enhanced and often local corrosion. Effective protective measures can be derived from knowledge of the corrosion process. Naturally-arising covering layers may be strengthened and developed as protective strata. Protection may be obtained by covering strata and coatings. Corrosion can be prevented by suitable construction and by cathodic protection. R. T.

402. How environment directs corrosion control. R. V. Jelinek. *Chem. Engng*, 1958, **65** (19), 163–8.—The relative importance of environmental factors in corrosion varies from one system to another. The most significant ones for corrosion control are pH, oxidizing agent content, temp, and velocity of the corroding medium.

The actual rate at which a given metal corrodes at a particular pH level depends on oxygen concn, protective films, hydrogen overvoltage, and metal-ion concentration. The paper includes data on the corrosion rate of iron and steel at the pH values between 0 and 14, and the corrosion rate of steel and other metals in water at different oxygen concn. The velocity effects are shown to be important as increasing stream velocity increases the corrosion rate by reducing surface film resistances and sweeping away corrosion products. In some special cases, as with cupronickel in sea water, critical velocities are found beyond which protective films are completely destroyed. Under conditions of highly turbulent flow, cavities may form in the liq, and this leads to a type of combined mechanical and chemical attack called cavitation erosion.

Biological influences are also important in a number of systems. Microscopic organisms such as barnacles cause electrolytic concn cells, leading to accelerated local corrosion on ships and marine structures.

Inhibitors offer control of corrosion rates and areas. The mechanism of action of inhibitors is discussed, and in a comprehensive table the properties and application of a number of commercial corrosion inhibitors are indicated. Cathodic protection is also briefly discussed in the paper. M. F. M.

403. Corrosion in gas wells. (In German.) W. F. Oxford. *Erdöl u. Kohle*, 1957, **10**, 868–71.—Corrosion in high-pressure gas condensate wells is intensified by forcing production, depth increase, and increase of gas condensate deposits. The basis of corrosion in gas condensate wells seems to be the effect of CO_2 or low fatty acids, or a combination of both. Research by the NGAA has shown that a condensate well which produces from >1500 m depth at deposit temp >70° C and 100 atm pressure shows corrosion damage when the CO_2 cont of the gas exceeds 0·2 vol %. Flow rates have a notice-

able effect on corrosion. Generally Christmas trees and well tubings suffer the severest corrosion. On economic grounds most firms have developed an anti-corrosion programme. Inspection of the Christmas tree and tubing calibration are useful but time-consuming methods for determining corrosion. For regular, quick observations coupons are used and the Fe cont of the H_2O raised is determined. Corrosion protection by chemicals seems hopeful and gives satisfactory results, but work is required to bring more effective and cheaper inhibitors into commerce. Methods for introducing inhibitors into the annular space with protective filling appear adaptable. However, there is currently no known possibility of casing protection if production be through the annular space.

R. T.

404. Contribution to the study of corrosion from emulsifiable oils according to IP 125. B. Cinti. *Olii Minerali*, 1958, **35** (11), 395–6.—A procedure is described which allows a better evaluation, as well as a documentation, of the results obtained by the corrosion test of emulsifiable oils upon cast iron plates according to IP Method 125/52T. The traces of oxides formed in the corrosion test are made to adhere to a transparent film. The print's reproduction remains unaltered on aging and lends itself to comparison with the results of other similar tests carried out in different periods of time.

(Author's abstract.)

405. How CATC fights marine corrosion in offshore tank batteries. R. M. Robinson. *Oil Gas J.*, 13.10.58, **56** (41), 117.—Corrosion protection system designed to guard against external corrosion of submerged parts in the splash and atmospheric zones, and against internal corrosion in ballast and oil storage tanks. For submerged zones cathodic protection is employed, whilst barrier protection is given to splash and atmospheric zones in conjunction with design to reduce exposed areas. For ballast zone cathodic protection is unsuitable, so inhibitors are used instead; also for production equipment and storage tank, the latter being periodically drained to draw off B.S. & W. G. A. C.

406. Corrosion-inhibitors in petroleum. T. Markovic. *Nafta (Yugoslavia)*, 1958, **9** (9), 270–4.—The use of inhibitors in the petroleum industry plays a big part in the prevention of corrosion. The efficiency of inhibition is discussed from the theoretical point of view. It is possible to show that some types of inhibitor work quite effectively in preventing corrosion. The use of inhibitors by the American petroleum industry, refiners, oil wells, gasoline pipelines, and the limitations of the use of existing inhibitors are pointed out.

(Author's abstract.)

407. How to reduce fuel-gas-line corrosion. L. Resen. *Oil Gas J.*, 3.11.58, **56** (44), 107.—Water injectors installed upstream of regulators on fuel-gas line to each heater allowed easy washing away of salt concn. Proper design of fuel-gas take-offs to minimize picking up of contaminates which would otherwise accumulate in headers where several burners are in use considerably reduces corrosion. G. A. C.

SAFETY PRECAUTIONS

408. Safe welding on gas field pipelines. J. S. Powell and H. M. Curtis. *Oil Gas J.*, 10.11.58, **56** (45), 135.—Safety investigation by Southern California Gas Co. shows that before welding is commenced air should be cleared from lines with gas. The practice of "drifting gas" out of open-end large dia pipe to prevent entry of air is not effective; a much greater flow is required, and this would be unsafe to discharge.

Purging should be done through bottom opening. Confirmation of 100% purging should be obtained by test. Controlled fire welding is safe only when the welder progressively "muds" or tapes behind any cut or open joint. G. A. C.

ECONOMICS AND MARKETING

409. U.K. oil imports increase in first half of 1958. Anon. *Inst. Petrol. Rev.*, 1958, **12** (141), 326–7.—Statistics of crude and products from all parts of the world in tabular form. They show an increase compared to the first six months of 1957 of 649,774 thousand gal.

E. M. I.

MISCELLANEOUS

410. Find viscosity index by nomograph. D. S. Davis. *Petrol. Refin.*, 1958, **37** (9), 330.—The V.I. of oil can be determined conveniently by means of a line co-ordinate chart constructed in accordance with the method of D. S. Davis if Saybolt visc at temp of 100° and 210° F is known.

M. F. M.

411. Some applications of high nickel alloys in the petroleum industry. Pt I. G. L. Swales. *Petroleum, Lond.*, 1958, **21** (11), 391–5.—Of the high nickel alloys, the nickel–copper alloy, Monel, finds the most widespread application in petroleum engineering. Its usefulness stems from its good fabrication characteristics combined with good resistance to a wide range of corrosive environment, including sea water, corrosive oil, well brines, the mineral acids, and caustic alkalis.

Monel sheathing can be successfully used for the protection of offshore drilling structures, particularly for the tidal and splash zones of drilling platforms. The most favoured method of applying Monel protection is to weld thin sheets (usually 16–18 gauge) to the piling. Monel K finds application for non-magnetic drill collars in oil-well surveying. The use of such non-magnetic drill collars allows the magnetic survey instruments to be located near to the drilling bit, yet outside the range of extraneous magnetic influences arising from the steel drill string.

Problems associated with the operations of extremely corrosive wells have necessitated a fresh appraisal of materials for valves, pumps, sucker rods, and other equipment, and Monel alloys have again proved satisfactory for construction of such components. Monel exhibits good resistance to corrosive acids and sulphur cpds, which promote rapid attack on mild steel. The use of Monel, Inconel, and other chromium nickel steels in dist, cracking, reforming, and hydrodesulphurization processes is discussed in the paper. M. F. M.

412. Free hydrocarbon radicals: their reactions in the gas phase. Pt I. A. F. Trotman-Dickenson. *Petroleum, Lond.*, 1958, **21** (10), 371–4.—The study of free radical reactions has developed through three stages. The first stage has been

concerned with proving the existence of radicals in reactions. The second stage consisted of attempts to describe many photolysis and pyrolysis reactions in terms of a series of elementary radical reactions, for many of which there was little direct evidence. At present we are in the third stage of development, and it is now possible to plan to investigate the reactions of specific radicals with a variety of substances. These three stages in the development of free radical chemistry have been closely linked with the improvement of analytical techniques in the past two decades.

Radical reactions are classified as follows: (1) decomposition of normal molecules and combination of radicals; (2) transfer reactions; (3) disproportionation reactions; (4) decomposition of radicals and addition of radicals to unsaturated cpds; (5) isomerization of radicals; (6) reaction of biradicals involving such substances as methylene and ethylene. The photolysis of ketones, aldehydes, or metallic alkyls is the best source of radicals for kinetic studies, but because of the very low energy yield it can not be used synthetically. Other methods of formation of free radicals are described and data are presented on the activation energies and " A " factors for the radical decomposition of organic molecules. M. F. M.

413. Application limits of combustion diagrams. (In German.) F. Schuster. *BrennstChemie*, 1957, **38** (15–16), 246–9.—Ostwald's conventional combustion triangle, in which the constituents of combustion gases are considered always as CO, cannot hold good, for in incomplete combustion H_2 occurs always with CO. The original form suffices practically for low cont of combustible constituents from H_2-rich fuels, if the graphic CO-val be considered as concn for the sum of the combustible constituents. At higher cont of combustible constituents the diagram must be so constructed that the ratio H_2-CO = 1–2 to 1–1. The difference between graphic and practical analytical val is then smaller when using the original form of the combustion triangle. The combustion triangle in its original form then permits its use so much further the greater the quotient % C : % H_2 is in the fuel. R. T.

414. Energy studies. R. Regul. *Inst. Petrol. Rev.*, 1958, **12** (141), 299–306.—This economic survey for the six countries comprising the E.C.S.C. uses the kilocalorie as its unit of calculation and draws up balance sheets for overall energy supply, apparent consumption, and consumption and effective energy during 1955. These tables are broken down into types of energy and fuels producing it. Calorific values of forms of primary and secondary energy are given and the efficiencies of conversions from primary to secondary. Efficiency rates of energy utilization are tabulated, and percentages are given for input and output of energy broken down into solid fuels, liq fuels, gas, and electricity. A further table lists crude energy requirements for various conversion processes. Estimation of future trends is discussed, along with economics of substituting one type of energy for another. Tables of future energy requirements are given. E. M. I.

415. Middle East oil. V. S. Swaminathan. *Engineer, Lond.*, 1958, **206**, 954–60.—Proven Middle East reserves (end 1957) *ca* 23×10^9 tons, approx 65% of world; production 17×10^7, ref capacity 53×10^6. Oil and gas estimated to yield 24% of energy for OEEC countries in 1960. Post-war Middle East petroleum development is reviewed and various statistics tabulated, including OEEC countries consumption/production and pattern of product demand. Brief history of concessions in Middle East is given, and breakdown of present Middle East companies according to controlling groups. Pipeline and tanker loading facilities are surveyed and developments in near future discussed, including possible Suez Canal improvements, and factors governing pipeline compared to tanker for petroleum transport. U.K. trade with Middle East is considerable, exports to latter (1957) being £154 million (5% of total) and imports therefrom (mainly petroleum) £211 million. V. B.

416. Fifty years of Iranian oil. Anon. *Inst. Petrol. Rev.*, 1958, **12** (141), 307–10.—This article lists the proceedings which celebrated the fiftieth anniversary of the Iranian oil industry. Summaries of four of the papers which were presented are given: " The Iranian Oil Industry, Past, Present, and Future," " Oil Exploration in Iran," " Drilling of Ahwaz No. 5, Key Exploration Well in Khuzistan," and " Oil Marketing in Iran." E. M. I.

417. The petroleum industry and the DSIR. Anon. *Petrol. Times*, 21.11.58, **62** (1599), 944.—Points of interest from the first report of the Research Council for the period Nov. 1956–Dec. 1957 are given, and include study by Chemical Research Laboratory of corrosion of metals in flowing water, purification of elements employing zone-refining techniques, preparation of ion-selective polymer films. In fuel research, investigations into new processes for gasification of low grade coal and synthesis of liq fuels and chemicals were carried out, and also into changes which occur in residual fuels on storage. The Geological Survey has produced up-to-date geological maps, and gravity measurements have been made in E. Anglia. G. A. C.

418. The 134th meeting of the American Chemical Society. Anon. *Petrol. Times*, 7.11.58, **62** (1598), 908.—This is a review of some of the papers presented at Chicago and includes " The Nature of Matter," " Energy Sources," " Measurement and Instrumentation," " Mathematics and Computers," and " The Technical Man." A symposium on the chemistry of friction and wear dealt with adsorption and film properties of polar organic cpds, solid–solid and solid–gas interfaces, and solid–liq interfaces, including the role of the lubricant. Several papers were also presented on thermodynamic properties of hydrocarbons, and on the origin, migration, and accumulation of oil. G. A. C.

419. The International Atomic Energy Conference. Anon. *Petrol. Times*, 21.11.58, **62** (1599), 948.—Abstracts are given of some papers presented at the Second International United Nations Conference on the Peaceful Uses of Atomic Energy held in Geneva, Sept. 1958, and include such subjects as flow measurement, use of nuclear radiation in chemical processes, use of nuclear explosions, use of nuclear energy for purposes other than generation of electricity, modification of polymers, and corrosion of steel in presence of H_2S. G. A. C.

BOOK REVIEWS

Handbook of the Petroleum Industry. Ed. George Sell and H. A. Dossett. London: George Newnes, 1958. Pp. vi + 213. 25*s*.

The main purpose of this book is, according to the publishers, to give " a background of information for young people considering a career in the petroleum industry and for those already employed " in oil." "

There are 16 sections which have been contributed by 12 authors (among whom are the two editors), and which describe the principal aspects of the oil industry. Necessarily such coverage is brief, ranging from three pages for the section on tar sands to 27 for that on drilling and production, but no significant part of the industry appears to have been overlooked (even a section on petrol from coal is included), and a useful glossary of petroleum terms forms the final section. As is inevitable when a number of authors is involved, the style varies somewhat, from the fairly technical manner in which the sections dealing with drilling and production and with refining have been written, to the somewhat less formal chapters on distribution and on present uses and future prospects of oil, although of course some such variation in style is to a certain extent dictated by the subject matter under discussion. It should not, however, be thought that even in these chapters there is any undue " writing down," and for the parts of the book more concerned with technical matters, such as, for example, exploration methods, some general technical background and vocabulary in the reader is assumed; the mention in the foreword of " the student nearing the completion of his academic training " indicates the readership standard the editors had in mind and which they have successfully achieved.

Some repetition is in the circumstances to be expected, *e.g.* the definition of diesel index occurs three times (pp. 92, 133, 199).

Where necessary useful diagrams, illustrations, and tables are included, although more attention might have been given to uniformity of units. Thus, in the two facing diagrams dealing with various aspects of refining on pp. 102–3, in one the temperatures are in ° C and in the other ° F; the diagram depicting the pattern of U.K. petroleum imports (p. 82) and the corresponding table (p. 83) give the quantities in gallons, although the detailed analysis of U.K. consumption (pp. 167–8) is in tons, whereas the world production and refining statistics (pp. 75–7) are in metric tons; for a book of this type the difference (of about 2 per cent) between the two types of tons is not significant, but the terminology could be confusing to the type of reader for whom the book is intended.

A feature of interest and value is the details concerning the activities of the various U.K. companies engaged in the petroleum chemicals field (pp. 159–60), the listing of exploration companies given in Section 15, and especially the accompanying charts showing the complex ramifications of the BP and Shell groups of companies; the compiling of this information must have required considerable research.

Considering the scope of the work very few errors have been detected and the only comments on this point that are called for are: the statement (p. 199) that in thermal cracking " the reaction is due to temperature alone," pressure of course being also an important factor; on p. 182 the expression " billion " is presumably used in its U.S. sense of 10^9 and not the U.K. one of 10^{12}—it would have been preferable to use, as has been done elsewhere in this section, the expression " thousand million "; in the very useful chapter on careers in the oil industry, where the general educational requirements for skilled employment are discussed, mention is rightly made of the IP—however, the statement that the Membership (or Associate Membership) category is related to the attainment of a definite standard in the technology of petroleum cannot be taken as a correct rendering of the Institute's requirements for admission thereto; finally, surely the " petro " in petroleum (p. 203) is derived from Greek and not Latin? No misprints have been noted; there is a good index.

The various sections in a book of this type could be arranged in a variety of ways. That chosen by the editors appears to be reasonably logical, with, however, the exception that it might have been better to put the section on the history of the industry first, rather than to start with the geology of oilfields, and that within this latter section the portion dealing with the origin of petroleum might have been more suitable at the beginning rather than in the middle of this section. Also, the section on careers, of which mention has already been made, could have been a suitable concluding section rather than, as at present, appearing in the penultimate position.

The book can be recommended as giving an excellent survey of the various facets of the petroleum industry and as indicating the very wide scope that exists therein. Anyone considering entering the industry cannot but benefit from reading it, and the statement in the foreword that " the contents of the work will undoubtedly prove of interest to all those already engaged in the many branches of this world-wide industry " is certainly justified by the wide range of information the book provides. V. B.

Nomograms for Chemical Engineers. Om. P. Kharbanda. London: Heywood and Co. Ltd, 1958. Pp. xi + 247. 80*s*.

It is quite true, as the author points out in his introduction, that in spite of the large and increasing amount of graphical design information available, the chemical engineer is apt to spend an inordinate amount of time in locating the right equation or method to use in given circumstances. This is especially true of the man who is not a full-time designer, but engaged in process plant technology. At intervals which are frequent, but not so frequent as to establish an instinctive pattern of behaviour, he wants to run his slide rule over a plant to see whether its performance is or is not abnormal, or over a half-formed project to see whether its size and shape are reasonable and worthy of closer study.

Dr Kharbanda has done a real service to the profession in bringing together a hundred of the most universally useful nomograms covering physical properties of materials, a selection of unit processes, and some equipment design. The book is admirably shaped for its purpose, the size giving legibility without cumbrousness, and the spiral binding enabling any page to be laid perfectly flat. A nice balance is struck between the two extremes familiar to nomogram users—on the one hand, the bare presentation without comment, which inevitably raises suspicions in the user's mind, especially over the more tortuous examples; and on the other hand, a confusing wealth of detail on derivation and methods of construction. Dr Kharbanda gives concisely for each nomogram its theoretical or empirical basis, the original reference, one or two other relevant references, a comment on its use and mis-use, and sometimes a worked example.

This book is really an anthology, and Dr Kharbanda therefore faces the inevitable difficulty that no user will find

in it exactly what he wants. Without doubt, however, he has succeeded in covering a large part of the chemical engineering field in such a manner that the book is of general use to any chemical engineer, no matter what his special interests, probably the first time that this has been achieved.

Any criticisms that can be made are minor, and in some cases relate to the original nomogram rather than to this version. There are a few in which the original scales were untidy and would have benefited from a little more attention during their translation; in one case the scale between the 1 and 2 graduations is divided into seven unequal parts to which it is extremely difficult to assign values. The permeability constant nomogram cannot be used without reference to the original work, as the co-ordinates for the systems are not given; and although the viscosity–temperature charts for hydrocarbons are assigned a place, they are not actually included. In the fluid flow section it would have been convenient to find one of the simple friction loss graphical methods (*e.g.* Kroll, *Chem. & Met. Engng*, March 1945) instead of, or in addition to, graphical applications of the Fanning equation, which can be entered only with rather complex functions of the known parameters.

The book is almost entirely free from accidental errors; during a fairly close scrutiny only one translation error and one minute typographical error were discovered.

It can be said with confidence that any chemical engineer in a hurry will give Dr Kharbanda's book a permanent place within easy reach. A. J. C.

Laboratory Distillation Practice. E. A. Coulson and E. F. G. Herington. London: George Newnes, 1958. Pp. x + 166. 25*s*.

Drs Coulson and Herington have succeeded in producing a useful and attractive book covering elementary distillation theory, the construction, testing, and operation of laboratory fractionating columns and ancillaries, and azeotropic, extractive, and continuous distillation. It is well bound and illustrated and should form a useful addition to the library of the student or of the practising chemist who uses the techniques. Drs Coulson and Herington have in fact succeeded in what they set out to do.

The flood of journal literature on the subject of laboratory distillation over the past 25 years and the great advances made in the various techniques is well known. Since 1949 there have appeared the books of T. P. Carney (1949) and F. J. Zuiderweg (1957), which cover very much the same ground as the present volume and have the same end in view—that of gathering together the mass of uncorrelated literature. Unless some new developments take place in this field or some new method of presentation or new applications are involved, it would appear that the subject could hardly bear another book.

Nevertheless, it is too often true that the student of organic chemistry or petroleum technology approaches his studies with a very meagre knowledge of distillation methods and theory; the process is, of course, of vital importance in these subjects.

It is also true that there is room for progress in the distillation field, particularly in the petroleum industry, in the study of the correlation of laboratory and large-scale methods from the engineering and product quality point of view. The study of hydrocarbon composition of the petroleum lubricating oil range involving improved separations in high vacuum distillation techniques also comes to mind.

While problems such as these probably require more advanced and larger scale methods it is unfortunate that they are not touched upon in the more elementary or laboratory textbooks. J. O'D.

Anti-Corrosion Manual. 1958 edition. London: *Corrosion Prevention and Control* (Scientific Surveys Ltd), 1958 Pp. xii + 260. 50*s*.

It is not possible to review this so-called "Anti-Corrosion Manual" as a serious scientific or technical publication, since the majority of the articles are written from an advertising aspect and are generally superficial and uncritical. The articles are interspersed with advertisements, and the book includes a buyer's guide to advertisers in the sponsoring magazine.

The first four articles on corrosion and its prevention are by well-known specialists on the subject and serve adequately as an introduction, but it should be noted that all these articles have already been published elsewhere.

The following section on corrosion-resistant materials consists essentially of summaries with reference tables of physical properties.

Preparatory treatments of metals prior to the application of protective coatings are dealt with in a superficial way, which would be of little value to a technician who needed precise information on this subject.

Apart from an article on marine paints, the section dealing with protective paint coatings is of low standard, the articles being written in a non-critical way and giving only the advantages of different types of coatings. The final article in this section, called "Recent Commercial Developments," degenerates into straight advertising.

The other articles in this book are mainly written from the advertising point of view.

A book of this nature, which claims to give the most concentrated knowledge available on products, processes, and techniques for corrosion prevention, but which, apart from a few articles, consists essentially of trade literature, can serve very little real scientific or technical purpose. The specialist in corrosion prevention has sound scientific sources of information. The engineer searching for guidance on coatings to prevent corrosion would be left in a state of confusion after reading this book and would get very little guidance as to which type of coating to use, since there is no critical discussion of the relative value of different types.

To sum up, a rehash of trade literature with a veneer of general principles should not be classed as an "Anti-Corrosion Manual." H. B. F.

Eye Irritation from Solar Radiation of Organic Compounds and Nitrogen Dioxide. E. E. Harton, Jr, and C. C. Bolze. San Marino, California: Air Pollution Foundation, 1958. Pp. 61. $3.00.

This Report No. 23 of the Air Pollution Foundation covers statistically designed experiments using olefins, paraffins, ring compounds, solvents, and other organic materials, and full details and results are given. In general, olefins caused more eye irritation than paraffins and branched-chain olefins more than straight-chain. Olefins with internal double bonds also gave more irritation than those with terminal bonds.

Commercial solvents produced very little irritation and no significant differences were found.

Air Pollution Effects of Irradiated Automobile Exhaust as Related to Fuel Composition. E. A. Schuck, H. W. Ford, and E. R. Stephens. San Marino, California: Air Pollution Foundation, 1958. Pp. 91. $3.00.

"Photochemical smog" was produced by irradiating diluted automobile exhaust and its intensity measured in terms of eye irritation, visibility reduction, and ozone

formation. Four fuels of different composition in the range 3–34% aromatics, 0–52% olefins, and 24–97% saturated hydrocarbons were used in five cars.

Good correlations were found between eye irritation and concentration of certain C_4 and C_5 olefins. This and car conditions influenced eye irritation.

Details of analytical methods, test procedures, and results are given.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren "Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the "Library Catalogue" published by the Institute.

000 SELL, G. *and* DOSSETT, H. A. Handbook of the petroleum industry. London, Newnes, 1958.

020 ASLIB YEAR BOOK. London, Aslib, 1958.

020 INTERNATIONAL CONGRESS OF COMBUSTION ENGINES, 1957 Conference—Zurich. Zurich, CIMAC, (1958). 890 p.

020 ORGANIZATION FOR EUROPEAN ECONOMIC CO-OPERATION. List of associations connected with the European engineering industries, 1958. Paris, O.E.E.C., 1958. 81 p.

020 VENEZUELA. *Ministry of mines and hydrocarbons.* Text of papers presented at the National Petroleum Convention, Caracas, Venezuela, September 9–18, 1951. Oklahoma, Technical office of hydrocarbons, (1951). 419 p.

050 DENTI, R. Italian–English, English–Italian technical dictionary, 4th edition. Milan, Ulrico Hoepli, 1958. 1225 p.

050 ERNST, R. Dictionary of industrial technics, including related fields of science and civil engineering. Wiesbaden, Brandsetter Verlag, 1958. 2 vol.

050 KEMPE'S ENGINEERS YEAR-BOOK 1959. London, Morgan Bros., 1959. 2 vol.

050 QUERE, H. *and* BENAMOU, M. Vocabulaire technique anglais–français de la chimie du pétrole. Paris, Dunod, 1957. 122 p.

050 ROYAL DUTCH/SHELL GROUP. Nomenclature: drilling technique and oil field development—English, Dutch, German, French, Spanish, and Rumanian. The Hague, Royal Dutch/Shell Group, 1949. 161 p.

050 WHITAKER'S ALMANACK 1959. London, Whitaker, 1959. 1188 p.

060 THE CHEMICAL SOCIETY. Tables of interatomic distances. London, Chemical Society, 1958.

060 NATURAL GASOLINE SUPPLY MEN'S ASSOCIATION. Engineering data book. 7th edition. Tulsa, Oklahoma, NGSMA, 1957.

090 CORROSION PREVENTION AND CONTROL. Anti-corrosion manual 1958. London, Author, 1958. 260 p.

140 FINNIE, D. H. Desert enterprise: the Middle East oil industry and its local environment. Cambridge, Massachusetts, Harvard U.P., 1958. 224 p.

210 WATERMAN, H. I., BOELHOUWER, C. *and* CORNELISSEN, J. Correlation between physical constants and chemical structure. Amsterdam, Elsevier, 1958. 120 p.

210 AMERICAN SOCIETY FOR TESTING MATERIALS. Knocking characteristics of pure hydrocarbons. Philadelphia, Pa., ASTM, 1958. 96 p. (ASTM special technical publication No. 225.)

220 COATES, V. J., NOEBELS, H. J. *and* FAGERSON, I. S. *editors.* Gas chromatography: a symposium . . . of the Instrument Society of America, August 1957. New York, Academic Press, 1958. 323 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. 1958 book of ASTM standards . . . Part 2: non-ferrous metals. Philadelphia, Pa., ASTM, 1958. 1345 p.

760 THRING, M. W. *editor.* Air pollution: based on papers given at a Conference held at the University of Sheffield, September 1956. London, Butterworth, 1957. 248 p.

810 HRYNISZAK, W. Heat exchangers: application to gas turbines. London, Butterworth, 1958. 343 p.

870 LITTMANN, E. R. *editor.* Methods of analysis for petrochemicals. New York, Chemical Publishing Co., 1958. 384 p.

900 INSTITUTE OF PETROLEUM. Competitive aspects of oil operations: report of the Summer meeting . . . June 1958. London, IP, 1958. 203 p.

930 INSTITUTE OF PETROLEUM. Tanker safety code. London, IP, 1958. 30 p.

950 NETSCHERT, B. C. The future supply of oil and gas. Baltimore, John Hopkins Press, 1958. 134 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

420. Study of the organic matter in sedimentary rocks. Y. Khalifeh and M. Louis. *Rev. Inst. franç. Pétrole*, 1958, **13** (9), 1247–52.—Oxidn of the organic matter in an alkaline medium has drawbacks, especially with calcareous rocks. Hence a new method has been used, the rocks first being treated with HCl, followed by oxidn in an acid medium. A dry method has been employed to find the amount of carbon (heating in an electric furnace at 850° C in a current of oxygen).

The ratio of the reducing power to the carbon content is viewed as significant with regard to the state of reduction. Plots of this ratio are made against the amount of organic carbon remaining to be oxidized. Source rocks show a rise of the ratio as the amount of organic carbon remaining to be oxidized decreases; lagoonal deposits show a slight drop; continental siliceous and clayey deposits show a marked drop; modern marine muds give a flat curve. In all cases the ratio was 0·8 or more at the start of the curve. G. D. H.

421. Current knowledge on the synthesis of dolomite. G. Baron and J. Favre. *Rev. Inst. franç. Pétrole*, 1958, **13** (7–8), 1067–85.—After reviewing the crystallographic properties of calcium and magnesium carbonates and dolomite, it is noted that in experimental studies on the formation of dolomite

X-ray diffraction methods must be used for identifying the products so as to preclude the misleading features of some solid soln.

Various mechanisms for dolomite formation have been proposed—diffusion in the solid state, hydrothermal synthesis, and solubility factors. Some experimental conditions used in studies are incompatible with the geological conditions seemingly involved in dolomite formation. Mechanisms involving precipitation from solution have attractive features, and diagrams indicating the solubility relations for various systems involving calcium and magnesium carbonates and CO_2 are discussed. The influence of the pressure of CO_2 is examined and also temp effects. Experiments on a $CaO : MgO : CP_2 : H_2O$ system at high CO_2 pressures have given giobertite. G. D. H.

422. A case history: wedging does make a difference. D. Whitaker. *World Oil*, 1958, **147** (6), 130.—The vol of the sand wedge abutting a dipping fault plane can form a significant part of the reservoir if the sand is thick. In the South Bell City field, Calcasieu Parish, Louisiana, the accumulation is in a fault trap where the sand pay is on the upthrown side of a normal fault and the vol of the sand wedge is sufficient to warrant detailed isopaching; it has been found to represent approx 5% of total reservoir vol. It is possible to contour the fault planes in the field and the gas/water contact is apparently at a constant elevation around the structure.

Details of the geometry of the field are given with the method of vol estimation. Diagrams show an interpretation of the structure of the pay sand, a fault map, and an electric log cross-section through the main fault. C. A. F.

423. Concepts of facies. C. Teichert. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2718–44.—Stratigraphic facies was recognized, defined, and named by Gressly in 1838. Before the end of the 19th century the concept of facies became firmly established, through the works of Mojsisovics, Renevier, and Walther, as referring to the sum of lithologic and palæontologic characteristics of a sedimentary rock from which its origin and the environment of its formation may be inferred. Similar or identical rock types have isopic facies, different rock types heteropic facies. Facies changes must be studied in horizontal as well as vertical direction, with the aim of reconstructing changes of environment in space and time. Genetically interconnected isochronous facies form facies tracts; genetically interconnected facies tracts form facies families. Heteropic facies in vertical succession form facies sequences.

When used to designate major stratigraphic sequences occurring in certain geographic, oceanographic, or inferred tectonic environments, the term facies loses its descriptive objectivity. E. N. T.

424. Diagenesis. Z. L. Sujkowski. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2692–717.—Most sediments are mixtures of many heterogeneous cpds and are chemically unstable. Low temp and pressure may permit a sediment to remain in metastable conditions for hundreds of millions of years, but normally changes occur, leading to the separation of different chemical cpds, with water and organic matter as the chief agents of change. The passive or active behaviour of these agents decides the direction and type of particular diagenetic processes, but the general tendency is an unmixing of unstable mixtures. This process is associated with the liberation of a very large amount of material from one sedimentary series and its introduction elsewhere, commonly with replacement by other rock material on a large scale. E. N. T.

425. High-speed digital computers in stratigraphic and facies analysis. W. C. Krumbein and L. L. Sloss. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2650–69.—Rapid expansion of facilities for high-speed computation at reasonable cost on a service basis makes it possible for the geologist to free himself of the routine computations involved in making facies maps. Some of the conventional procedures for compiling data and designing data cards are described, and a programme is given for computing facies percentages and ratios. This programme may be used directly on any IBM 650 computer with a standard wiring board. Suggestions are offered for application of the basic programme to a variety of three and four end-member systems. E. N. T.

426. Sulphur isotope abundances in petroleum and associated materials. H. G. Thode *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2619–41.—A study has been made of the sulphur isotope ratios for petroleum from many different oilfields in the U.S.A. and Canada. The S34/S32 ratio for petroleum varies by *ca* 4·5% as compared with a total spread of *ca* 9% for terrestrial sulphur. The single large oil pools appear to be uniform in isotopic content. Also, oils from widely separated locations in Alberta, found in the same reservoir rock, have similar sulphur isotope ratios. On the other hand, the actual sulphur content of these latter oils may vary by a factor of 10. This result indicates that there is little or no fractionation of the sulphur isotopes in the maturation of the oil in which sulphur is lost. The fact that the H_2S and its associated petroleum have similar sulphur isotope content is further evidence for this view.

The sulphur isotope ratio for petroleum would seem, therefore, to give information concerning the isotopic content of the source sulphur at the time of petroleum formation. This in turn would reveal something about the environment in which the petroleum was formed. E. N. T.

427. Surveys made from air aid remote exploration. M. E. Erfle. *World Oil*, 1958, **147** (5), 210.—The use of photogrammetric and electronic air survey methods for compiling accurate topographical maps is outlined. Vertical and oblique aerial photographs are taken, with overlap, and the position of the aircraft during flight can be determined by Shoran, which gives the horizontal position of each photograph at exposure, and a radar altimeter continually records the profile of the ground. The Shoran system comprises a pulse generator, transmitter, and receiver fitted in the aircraft, and a receiver coupled to a transmitter at each ground station. The aircraft set measures the time interval between the transmission of a pulse from the aircraft and the return pulse received from the ground station. C. A. F.

428. Permeability of oil-bearing rocks. Anon. *Petroleum, Lond.*, 1958, **21** (12), 451.—An experimental investigation has been carried out recently in Russia on the characteristics of the deformation of oil-bearing rocks under the influence of variable external pressure, in connexion with the filtration of oil through rock and the restoration of pressure in oil strata. The experiments were on a number of specimens of natural oil-bearing rocks mainly taken from the Caucasus oilfields. Pressures of up to 600 atm were used and the permeability of the specimen was measured by the drop in pressure for a given rate of filtration. The fluid used in the tests was kerosine. A methodical investigation was then made and curves of permeability (K) as a function of the external pressure (p_{ext}) obtained.

Measurements show that there is a linear law of filtration on the basis of which the permeability may be calculated and the experimental results also show that the curve of K against pressure (p_{ext}) may be divided into two types. For the first type the permeability is reduced with increased pressure but increases to its original value when pressure is reduced, thus indicating that the deformation of the specimen is reversible. With the second group, however, there appears to be a permeability hysteresis effect and the deformation of the specimen is not reversible.

It is evident, therefore, that contrary to the generally accepted view, oil-bearing rocks exhibit plastic properties under compression and that these properties are connected with the rock structure and the cementing matter. The correlation of the deformation of oil-bearing rocks and their mineral composition requires considerably more experimental data and much further work is necessary. M. F. M.

429. New look at salt dome geology may increase Gulf Coast reserves. Pt 1. Problems of detailed correlation. V. N. Sovinsky. *World Oil*, 1958, **147** (5), 180.—Regional problems of salt dome development and stratigraphy in the Gulf Coast salt dome province cannot be properly studied until the Miocene has been correlated. It is claimed that detailed Miocene correlation between fields is not possible because of sharp deltaic facies changes over short distances, but it is shown that, by using the long range correlation method in this area, it is possible to make regional correlations and that, in the Louisiana Gulf Coast area, the concept of widespread, sharp facies changes is incorrect.

Pt 2. Modified theory of salt movement. *World Oil*, 1958, **147** (6), 111.—A theory of salt movement for the Gulf Coast province is presented, in which the upward movement of the salt domes is related to sedimentary cycles in the Miocene in which at least 11 cycles can be recognized. It is assumed that the domes are dormant at the beginning of each cycle; sediments then accumulate above the structure and these " trigger off " the stage of upward growth of the dome, which continues until the end of the cycle. The final type of structure which is formed will depend on the differential rate between salt movement and deposition of sediments, and three possible types of movement are noted; if, for example, the rate of movement is equal to deposition rate there will be pinch-out of sands and shales.

The importance of the theory in relation to oil accumulation is emphasized, it being shown that stratigraphic traps on top of the last cycle are concentrated towards the flank of the structure, rather than towards the salt. These are mainly overlooked in exploration. It is claimed that periodic compressive stresses are necessary for the salt structures to form in the Gulf Coast area. C. A. F.

430. Texas' subsurface Ouachita structural belt. P. T. Flawn. *World Oil*, 1958, **147** (6), 141.—Although it is generally held that the frontal structures of the Ouachita trend in Texas and Oklahoma are barren of oil because of the proximity of metamorphism, it is relatively unexplored, and the presence of oil and gas in orogenic belts elsewhere suggests that the area is of interest to exploration. The geology of the Ouachita belt is described; it extends some 1300 miles and is exposed for 300 miles. In Texas the belt is a buried continuation of the mountains and can be divided into two segments, a N. and a W. limb. The N. limb, which extends N.–S. from Oklahoma to S.-Central Texas, contains a frontal unmetamorphized zone (with shales and sandstones of Stanley age) which is folded and thrusted, backed by metamorphics. The W. limb extends from S.-Central Texas to the Big Bend area, is geologically different, and the frontal zone is narrow or missing. The width of the belt is 50–60 miles in Texas, but very few wells have been drilled, the prospects being deeply buried. Of particular interest to exploration is the relation between the folded and thrust-faulted rocks of the frontal zone and the shelf and basin facies of the foreland adjacent to the structural belt. C. A. F.

431. In South Texas Wilcox trend natural gas prospects are good. F. L. Oliver. *World Oil*, 1958, **147** (7), 123.—Economic conditions are encouraging the search for gas in the Wilcox trend of S. Texas. This extends NE.–SW. from N. Duval County to Lavace County, and Wilcox sands are found below *ca* 600 ft subsea. 193 Wilcox fields have been found along the trend, *ca* 70% of these yielding gas and condensate. The sands present engineering problems; they consist of heterogeneous beds of a shallow water environment and there is much lateral variation. Structures are of low relief, typified by elongated anticlines with normal down-to-the coast faults. Porosity averages 20% and permeability 76 mD; connate water is approx 35%. Water drive is unlikely, but water and gas coning can be serious problems and water blocking is a major hazard. These conditions tend to reduce the amount of recoverable oil. Secondary recovery methods are feasible for some reservoirs, but the best way of increasing recovery is to increase well spacing. Overdevelopment can bring economic failure.

The history of exploration and development in the area is outlined. There have been recent discoveries which will encourage drilling in the area of the Rio Grande Valley, hitherto sparsely drilled. The lower Wilcox offers the best prospects. Detailed geological studies combined with geophysics are probably the best means for finding new fields in the area. C. A. F.

432. Study reveals Mississippi series possibilities. S. B. Anderson. *World Oil*, 1958, **147** (7), 136.—The correlation of the Mississippian in N. Dakota is confused because of facies problems in the Upper Madison. There are several facies changes in the group, notably limestone variations which may form good stratigraphic traps. Porous limestones may be productive in the area if: (1) they contain permeability barriers; (2) they are associated with structures; and (3) if they are truncated by the Mississippian unconformity and sealed by secondary anhydrite. Facies changes in the Upper Madison are discussed; the group comprises the Englewood, Madison, Lodgepole, Mission Canyon, and Charles, and control data include sample, electrical, and radioactivity logs. Lithology and facies changes and nomenclature in each of these formations are described and a series of cross-sections is given. C. A. F.

433. Sulphur isotope abundance in hydrocarbons and source rocks of Uinta basin, Utah. A. G. Harrison and H. G. Thode. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2642–9.—The sulphur isotope abundances in the free asphalts, asphalts extracted from the supposed source rocks, and the inorganic sulphur cpds of the source rocks of the Uinta basin have been determined. The results show that both the asphalts and inorganic sulphur cpds become more and more enriched in S34 with decreasing age and decreasing depth of the deposits, the youngest sediments being enriched 31% as compared with 20% for sea water sulphate. This one-to-one correspondence between S34/S32 ratio and age and depth of deposits is, in view of the changes in the nature of controlling environment which occurred, strong evidence in favour of a biological theory of S34 enrichment in inland lakes and seas.

The free asphalt and asphalt extracted from the source rocks were found to have almost identical sulphur isotope ratios in the case of wurtzilite and albertite. However, in the case of ozokerite, the asphalt extracted from the supposed source rock has quite a different S34/S32 ratio from that of free asphalt. E. N. T.

434. Exploration possibilities in SW. Nebraska look good. R. F. Svoboda. *World Oil*, 1958, **147** (5), 191.—Drilling activity in SW. Nebraska is increasing since recent fields have indicated that there are possibilities of important reserves in the Mississippian and Cambrian which are overlain unconformably by the Pennsylvanian. Excellent conditions for accumulation occur where pre-Pennsylvanian limestones have been truncated and weathered along the unconformity, and there have been recent discoveries in the Pennsylvanian Lansing–Kansas City limestones where development of adequate porosity and permeability is an important factor in accumulation. 10 refs. C. A. F.

435. Production tests start on Kenai Peninsula. Anon. *World Oil*, 1958, **147** (7), 164.—Oil has been found on the Kenai Peninsula, *ca* 40 miles SW. of Anchorage, Alaska. The discovery, Swanson River Unit 1, has recently been producing 500 b.d. of 32° oil which is trucked to Seward for lifting to California. This is the first major producing area to be found in Alaska. C. A. F.

436. Sedimentary reflections of depositional environment in San Miguel Lagoon, Baja, California, Mexico. H. B. Stewart, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2567–618.—The environment of deposition at San Miguel lagoon is characterized by wide ranges in the measured factors. When the lagoon is isolated from the ocean, large fluctuations in bottom-water temp with time mask any variations from place to place. Chlorinity, on the other hand, changes so slowly with time that areal variations are meaningful. Dissolved oxygen concn and pH vary diurnally and areally, and these variations are used to delineate five aqueous environments within the lagoon.

Three different types of sediment within the lagoon are related to the following processes of transportation and deposition: wave processes, river processes, and slow deposition from quiet water. Distribution of foraminifera reflects the influence of the barrier in restricting water exchange with the ocean. Calcium carbonate values in the sediments are low (0·2–2·3%), and the erratic distribution pattern results from variations in the sources, rate of dilution, and physicochemical factors. E. N. T.

437. Geologic outline of natural regions of Mendoza, Argentina. R. N. Dessanti. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2670–91.—The province of Mendoza, Argentina, is divided into nine natural regions, each with distinct physiographic and geologic characteristics: Frontal Cordillera, San Rafael Mountains, Precordillera, Principal Cordillera, Extra-Andean basin, Huayquerías, Huarpes Bolsón, Uspallata Bolsón, and Travesía Bolsón. The geologic time scale is well represented pre-Palæozoic, Palæozoic, Triassic, Jurassic, Cretaceous, Tertiary, and Quaternary. Several orogenic movements are recognized: Ancient (Huronian?), Permo-Triassic (Variscan), and Andean.

Mineralization is related to abundant volcanism and to these movements, especially the later ones. Gypsum is found in abundance in the Upper Jurassic; limestone is plentiful in the Lower Cretaceous and is used for cement from the Ordovician; oil shales occur in the Upper Jurassic; petroleum is produced from Upper Triassic, but probably has its origin in Palæozoic; ground water comes from aquifers in the Quaternary alluvial cones. E. N. T.

438. The discovery of Hassi Messaoud. H. I. Ortynski. *Rev. Inst. franç. Pétrole*, 1958, **13** (6), 944–9.—The N. Sahara, except for the central region, is covered mainly by continental deposits ranging Mio-Pliocene to Quaternary in age, and they hide the subsurface structure. Palæozoic rocks outcrop in the W., and Mesozoic outcrops in the Median Zone separate the Tertiary and younger rocks of the W. Zone from those of the E. Zone. Studies of the older rocks were made to establish the stratigraphy, and to link with drilling data. A course grid of gravimetric measurements was begun at the end of 1948, and the result guided the choice of areas for seismic work. The first reflection work was not especially conclusive, and refraction work was undertaken which proved most valuable; this started in the Mzab region, and the Berriane and El Golea wells began where the Cretaceous outcrops in the same region. Reflection work was used in restricted areas for special studies. The Ouedi Rharbi well showed sandstone reservoirs with hydrocarbon shows in the Lower Devonian, but variability in these rocks has so far been responsible for the failure to find a commercial accumulation. The Berriane well went through Cretaceous and Jurassic, and in sandstones below the Salifère and infra-Salifère clays had oil and gas shows, as well as high-pressure salt water. The upper sandstones were definitely Triassic. This well was on the E. flank of a large high. The Hassi el Hadjar well was located on a Cretaceous outcrop to the E., which coincided with a gravity anomaly. The section was similar to Berriane, but beneath the Salifère were Triassic sandy clays, greatly reduced Gothlandian, and, at 3600 m, Ordovician (?) quartzites. Farther E., refraction surveys had indicated a high near the old Hassi Messaoud wells. The probable presence of Salifère cover led, along with other data, to drilling the Hassi Messaoud discovery well in 1956. Wet gas has been found in Triassic sandstones at Hassi er Rmel (Tilrhempt high). G. D. H.

439. Burma Oil drilling first exploratory test in the Irrawaddy Delta region. Anon. *World Oil*, 1958, **147** (7), 167.—A well is being drilled at Hteingyun near Kyaiklat in the Irrawaddy Delta. This is the first test in the region, and it follows a detailed seismic survey of the area. There are no surface indications in the area and the nearest well is *ca* 150 miles W. of Kyaiklat. C. A. F.

440. Japanese field discovered. Anon. *Oil Gas J.*, 24.11.58, **56** (47), 61.—A well in S. Hokkaido has tested 31 brl of 41° API oil and 35,000 cu. ft. wet gas/day from a 30-ft Pliocene sand at 2788 ft. The well is believed to be on the S. flank of a structure more than 50 miles SW. from the nearest productive wells at Barato. J. C. M. T.

441. Contribution to knowledge of Palæozoic micro-faunas: micropalæontological studies on the marine Carboniferous of Asturias (Spain). M. Lys and B. Serre. *Rev. Inst. franç. Pétrole*, 1958, **13** (6), 879–916.—Samples obtained from the Griottes, Cañons, and Lena formations (Upper Visean, Namurian, and Westphalian A,B,C) were studied. The Upper Visean had an abundance of radiolaria, and conodonts were excellent markers. The Westphalian had an abundant and distinctive fauna with *Fusulinella böcki* and var. *delepinei*, *Pseudostaffella sphaeroidea*, and *Ozawainella* prominent. The last two forms were abundant in the Westphalian C along with *Fusulina cylindrica*. Asturias is an area which may allow the development of correlations with North Africa, Russia, and the Indo-Pacific.

A table shows the distribution of the various forms, and a number of forms are illustrated. G. D. H.

442. Palynological study of some Mesozoic samples from Dorset (Great Britain). J. Lantz. *Rev. Inst. franç. Pétrole*, 1958, **13** (6), 917–43.—The samples were mainly clays and marls of Charmouthian to Wealden age. They were treated successively with nitric acid, a mixture of hydrofluoric acid and oxygenated water, and again with nitric acid. 17 out of 22 samples were fossiliferous, containing 200–4000 sporomorphs/g. 20 genera and 30 species (four new) were found. Quantitative studies were made. There were 14 species of pollen (mainly gymnosperms) and 16 species of spores. Two main associations were noted, one extending from the Charmouthian to the Lower Purbeckian, and the other occurs in the Upper Purbeckian–Wealden.

The various species are described and illustrated, the samples are listed; a table gives numerical data on the stratigraphic distribution of various forms. G. D. H.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

443. Optical analogue computer simplifies gravity analysis. R. W. Baltosser and S. W. Wilcox. *World Oil*, 1958, **147** (5), 188.—An optical analogue computer has been developed for interpreting gravity data. It uses accurately scaled geological cross-sections in which each significant geological unit

is given an opacity proportional to the assumed specific gravity of the formation. This shaded model is prepared on transparent film and is placed over an illuminated opening in contact with an optical graticule which filters equal amounts of light for each of the unit areas. When the cross-section is superimposed on the graticule the light is arranged to fall on a photo-electric cell which counts the number of filter openings. An example of its use is given. C. A. F.

DRILLING

444. Drilling controls discarded in steeply dipping formations. H. J. Reedy. *World Oil*, 1958, **147** (6), 115.—Wells have been drilled directionally in the Carter–Knox field, Oklahoma, in which no mechanical aids such as whipstocks have been used. Control is by varying weight and speed of rotation and by siting the surface location in such a position that advantage is taken of the direction and amount of drift under normal drilling conditions to enable the target to be reached at the required point. The area is one of steep dips and highly complex geology, the wells being drilled to the Bromide sand below 15,000 ft. Surveys of the wells have shown that the horizontal displacement of a well in areas of steep dip will be in an updip direction, greater inclination being obtained by increasing weight (unless the angle of deviation is close to the angle of dip). It has been found that an increase in rotation speed reduces inclination. Uncontrolled drilling in this area has resulted in important savings in drilling costs. C. A. F.

445. Nuclear diagraphy. A. Poupon and F. Lebreton. *Rev. Inst. franç. Pétrole*, 1958, **13** (7–8), 1086–101.—Logging utilizing the natural γ-rays is most sensitive using scintillation rather than Geiger counters, but the former cannot be used at such high temp. In order to get the true radioactivity of the formations, readings must be corrected for cement, tubing, and mud in the hole. The logs can be used for correlation, detecting clays or shaly rocks, and correctly placing recovered cores, whilst the devices can be used with soluble, insoluble, or gaseous tracers for detecting cement and zones of lost circulation, or determining injection profiles and studying fluid movements.

Analysis of γ-ray spectra can be used for estimating the relative amounts of K40, and uranium and thorium.

Neutron logging employs a neutron source, the neutrons being slowed by collisions, especially with hydrogen nuclei. The neutron-gamma device can be employed for assessing porosities under certain conditions because of the presence of combined hydrogen. Provided invasion is not deep, gas horizons can be recognized by using two different spacings.

The gamma-gamma device uses γ-ray bombardment, but investigates only *ca* 1 dm^3 compared with *ca* 100 dm^3 for the neutron-gamma device. The former is, therefore, affected by mud cake opposite permeable rocks; it can, however, be used to obtain porosities via the bulk density if the mineral density is known. G. D. H.

446. Russia claims progress in gas turbo-electric drives for drilling rigs. Anon. *World Oil*, 1958, **147** (6), 168.—It is reported that compact, turbo-electric drive units having capacities of 300, 1000, and 1500 kW are to be produced shortly in Russia. Diagrams show the schematic design of the units. Gas turbo-electric drives have been under development for several years and they have a number of advantages, enabling various kinds of cheap fuel to be used. At least two types of mechanism are reported; one is designed for a heavy rig for rotary and turbine drilling. The new units are expected to replace the diesel units now in use, which have many disadvantages, such as high fuel consumption and difficulties in assembly and transport. C. A. F.

447. Economics of drilling for Cretaceous oil on east flank of Denver–Julesburg basin. J. J. Arps and T. G. Roberts. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (11), 2549–66.—The Denver–Julesburg basin at present, with its hundreds of Lower Cretaceous fields and thousands of wells, represents a unique opportunity for statistical analysis. A "sample area" of 5,700,000 acres was chosen on the E. flank and a statistical correlation prepared of the estimated ultimate recovery per field and the number of delineating dry holes per field as a function of the productive field area.

This correlation shows some well-defined trends from which significant conclusions can be drawn. A frequency-density distribution of the fields found was then prepared and plotted *v.* ultimate field recovery, which again indicated a well-defined pattern.

A mathematical relation is presented, relating the number of fields of a given size found after drilling a known number of wildcats to the total number of fields of that size originally occurring in the sample area for the assumptions of: (1) random drilling in the productive trend; (2) pattern drilling in the productive trend; and (3) drilling on geophysical and geological leads in the trend. E. N. T.

448. Two-man crew operates hydraulic rig. E. McGhee. *Oil Gas J.*, 22.9.58, **56** (38), 92.—A hydraulic rig capable of drilling to 3000 ft is described. The mast consists of three columns, each of which is a hydraulic cyl for hoisting the drill stem. Rotary drive is by hydraulic power swivel. Power slips, mud pump clutch, and sand-line are hydraulically operated. Automatic drilling is possible. All equipment except mud and water tanks is trailer mounted with weight of 33,000 lb. A crew of only two is needed for all drilling operations. Round trips from 2500 ft can be made in under five hr. It is planned to build units for greater depths. J. C. M. T.

449. Chemical control of H_2S during drill stem tests. J. U. Messenger. *World Oil*, 1958, **147** (7), 111; *Canad. Min. metall. Bull.*, 1958, **51** (559), 716–18.—Chemical control of H_2S during testing of wells containing sour gas in Canada has been successful by using ammonium hydroxide as a neutralizer. This is more effective than sodium hydroxide, as the H_2S is neutralized in solution or in the vapour phase. The control of H_2S is important, for the drill pipe can contain toxic quantities of the gas. The soln of ammonium hydroxide consists of 26° Beaumé aqua ammonia diluted with 1 pt water, and this is injected into the pipe. Successive treatments can be given as the stands of pipe are pulled. Possible hazards in the method are noted. C. A. F.

450. Viscosity of clay suspensions. N. Street. *World Oil*, 1958, **147** (7), 151.—The visc of clay suspensions is briefly discussed from first principles. Visc is defined, and it is indicated that clay suspensions usually show "Bingham" or plastic flow which involves a friction factor in the basic visc equation. The value of visc measurements thus depends on the rate of shear at the time of measurement. Flocculation affects visc, as the floccules can act as individual flow units. The effect of anisometry in clay systems is discussed, together with the application of rheological properties to mud systems in drilling. 19 refs. C. A. F.

451. Wetting agents reduce pipe sticking. N. K. Tschirley and K. D. Tanner. *Oil Gas J.*, 17.11.58, **56** (46), 165.—A polyoxyethylene sorbitan tall-oil ester (an oil-dispersable nonionic surfactant) added in the ratio of *ca* 3/4 gal/brl of emulsion mud promotes an oil coating on drilling tools and mud solids which prevents sticking of drill pipe. A very low filtration rate is also obtained when this agent is added to an emulsion mud. J. C. M. T.

452. Five factors that affect drilling rate. P. L. Moore. *Oil Gas J.*, 6.10.58, **56** (40), 141.—Drilling rates are reduced by

high hydrostatic pressure resulting from high mud weight; the rate is at a max when pore pressure and drilling fluid pressure at bottom of hole are equal. Consequently drilling fluid pressure should be as low as practicable; with care it need be no more than 200 p.s.i. above formation pressure.

High bit weight and rotary speed increase penetration but also increase wear and deviation. The following relation is developed for optimum bit weight, W:

$$W = \left(\frac{K' C_r}{S N}\right)^{\frac{1}{4}}$$

where W = weight on bit (thousands of lb); N = rotary speed, rev/min; C_r = rig cost, \$/hr; K' = a const; S is given by:

$$S = \frac{D}{F}\left(B + C_r A + \frac{C_r E D}{2}\right)$$

where B = bit cost, \$; A = cost of handling and changing; E = rate of increase of trip time with depth; D = well depth, ft.

High mud visc and solids content and low filtration rate decrease penetration rate, which is proportional to the cube of the vol rate of flow, and inversely proportional to the fourth power of the equivalent bit nozzle dia. Oil in the mud increases the penetration rate, but may not be economic. Rate of penetration increases with hydraulic h.p. used, up to a limiting value. It is shown that:

$$H = \frac{4GQ^3}{1714} \text{ at this max value,}$$

where H = the surface hydraulic h.p.; Q = fluid flow rate, gal/min; G = a const depending on the geometry of the circulating system. 67% of the surface pressure or hydraulic h.p. should be expended through the bit for best results. Q must be sufficient to give an annular velocity of not less than *ca* 120 ft/min. Worked examples are given for typical practical examples showing how faster or more economical drilling may be obtained. J. C. M. T.

453. Humble has new completion method. Anon. *Oil Gas J.*, 17.11.58, **56** (46), 136–7.—A system of multiple completion doing away with the usual concentric arrangement of casing and tubing has been applied by Humble Oil and Refining Co. to five wells in Raccoon field, Austin County, Texas. Two or three strings of pipe hang side by side, each completed in a different horizon. The nest of pipes is cemented directly into the open hole, no casing, in the ordinary sense of the word, being employed. The cement is emplaced via the lowest string. Completion is by gun-perforating using an assembly which permits the gun to be aimed and so avoid shooting holes in adjacent pipe. Each string is of similar size to conventional tubing, the multiple strings being strapped together at the surface and run simultaneously with little additional rig time. Cost for a dual completion is 60% cost of two conventional wells; cost of a triple completion is half that of three conventional wells. Workovers can be done using wire line tools or macaroni strings. J. C. M. T.

454. Turbo-drilling at Lacq. C. Menetrier and J. Raynal. *Oil Gas J.*, 24.11.58, **56** (47), 64–8.—Field experience of turbo-drilling has been gathered at Lacq, S. France, since 1956, and 90,000 ft of hole have been made with this method. Compared with rotary drilling, drilling rate and daily footage have been substantially increased, but bit footage is only 60–80% as great, and round trips occupy 38% of total rig time. Best results are given with water as drilling fluid. Other requirements for success are a heavy bit-weight, and minimum pressure losses in surface installation and drill pipe. Turbo-drilling with diamond bits is successful in hard rock below 10,000 ft. Straight-hole turbo-drilling in crooked-hole areas is costly and troublesome; present hole-straightening methods are not satisfactory. Instruments which would aid the driller would be a surface-reading turbine tachometer and a mud circulating rate indicator. J. C. M. T.

455. Combating intermediate quantities of water in air/gas drilling. B. V. Randall, J. L. Lummus, and R. P. Vincent. *Petrol. Engr*, 1958, **30** (12), B26.—The principal deterrent to expanded use of air or gas as a drilling fluid has been the problem of controlling the influx of water into the well bore. Injection into the air or gas stream of dry, finely ground stearates, which impart a water-repellent film on bit cuttings, has been found effective for preventing balling of cuttings in the presence of small amounts of water. The use of such agents has permitted continued drilling in the presence of up to 2 brl of water/hr. Field tests have shown that use of a foaming agent would be an effective means of removing intermediate quantities of water (*i.e.* from 2–60 brl/hr) and bit cuttings from a well bore.

Results of lab evaluations of a number of foaming agents are included in the paper, and these show that the agents listed in the literature as best foamers are generally anionic. Case histories on the use of foaming agents in various wells situated in New Mexico are appended. M. F. M.

456. A new technique in air and gas drilling. F. W. Smith. *Petrol. Engr*, 1958, **30** (11), B37.—Water intrusion no longer determines the end point for air and gas drilling. A technique known as mist and slug drilling has extended the use of air and gas drilling beyond wet zones while maintaining dry drilling economics. The technique involves injecting into the air or gas stream certain chemicals which permit control of intruded water and contamination of air or gas drilling.

The success of mist and slug drilling has been demonstrated in numerous applications, some of which are quoted in the article. Its applicability, however, is limited to cases where water intrusion is less than 40 brl/hr. Mist and slug drilling will not penetrate red beds or salt formations at economical rates, and these formations erode rapidly.

A most important advantage of mist and slug drilling is the increased penetration rate in most formations along with an increase in bit life. Equipment required is essentially the same as that needed for air drilling. The principal difference results from higher pressure and vol required in mist and slug drilling (20–30% more vol and up to 800 p.s.i. more pressure).

Further study of chemicals is required to develop a foaming agent effective with high influx of oil and salt water and which incorporates economically a satisfactory corrosion inhibitor and bit lubricant. M. F. M.

457. Drilling contractor's viewpoint. N. W. Williamson. *Petrol. Engr*, 1958, **30** (11), B19.—This study has been conducted by taking a cross-section list of drilling contractors in the U.S.A. and Canada and asking their viewpoints. Questions were carefully planned and answers carefully analysed. It is believed that the article will give a true insight into the contractor's situation as it exists today and his outlook for tomorrow.

The financial picture is as follows. A fair gross profit is 17·7%. 1958 earnings of 76% of all contractors were less as compared with 1957 earnings. Costs rose 9·8% in 1958, mostly in terms of equipment and supplies. 60·8% of the equipment used was over five years old. Pumps need improving most, in the opinion of most contractors. Penetration rates, say 79%, cannot be increased using present equipment. Only 36% of U.S. drilling contractors are interested in foreign work and only 14% are engaged in work outside the U.S.A. Will conditions improve in 1959? No, say most. It will stay about the same as in 1958. M. F. M.

458. Improved cementing through automation. G. V. Copland and D. K. Smith. *Petrol. Engr*, 1958, **30** (12), B113.—Improvements in cementing compositions now make it possible to reduce or increase the density of a slurry from 10

to 20 lb/gal. The control and accurate measurement of such a wide range of densities in different cement systems has been made possible with the development of a new slurry weighing device called a Densometer. This device is accurate within ½ of 1% and has a response time of less than 3 sec. Basic design of the instrument utilizes an adaptation of the beam balance system which measures the fluid by a hollow beam scale. A pneumatic strip chart recorder provides a continuous record of the fluid density. Remote gauges may be provided at any point for visual readings throughout the cementing operation.

The density meter may be specially helpful in drilling areas where high pressure gas or air pockets are encountered. The meter would enable the immediate identification of these trouble spots in the mud system. M. F. M.

459. Fluid knock in mud pumps. S. L. Collier. *Petrol. Engr*, 1958, **30** (11), B49.—Detailed study of the characteristics of valve knock has established that this is a hydraulic knock and that it occurs when the pump operation causes the development of a void in the cyl. When the void is filled, usually just past mid-stroke, the fluid strikes the piston, causing a hydraulic shock wave and loud knock. Suction valve behaviour becomes abnormal during the hammering, but discharge valves are not disturbed. Knocking, therefore, occurs in the suction system rather than in the discharge system.

Oscillographic records show that shortly before the knock occurs, the flow velocity begins to rise and rises considerably above the velocity proportional to piston velocity. At the instant the knock occurs the velocity drops almost instantaneously. The calculated suction pressure rise, based on the sudden change of velocity, is approx that expected from the simple water hammer formula, and this evidence completes the correlation between theory and test data. M. F. M.

460. Additional mud storage at nominal cost. J. Cox and R. W. Scott. *World Oil*, 1958, **147** (7), 105.—A problem of providing additional storage for 500 brl of mud on an offshore drilling barge has been solved by converting a 10-ft dia fender which forms a part of the barge structure. Conventional tanks were unsuitable because the surface working area on the rig would be much reduced and costs would be higher. The fender column was used at a nominal cost of $12,000, no additional space on the rig being involved and with a minimum of construction work. Pumps were fitted to enable the mud to be transferred to the normal system and to agitate the column, preventing settling out. Details of the conversion are given and schematic diagrams show the layout. C. A. F.

461. New developments in gyp muds. R. J. Smith. *World Oil*, 1958, **147** (6), 138.—A mud additive consisting of a ferrochrome ligno-sulphonate material has recently been introduced, and it is now being used extensively for controlling the visc, filtrate loss, and gel strength of muds of various kinds, including gypsum muds. Many advantages include fewer fishing jobs and higher resistance to contamination. In the Williston basin, for example, gypsum muds could not formerly be used in weighted muds because of high gel strength. The new material enables gypsum muds to be used over a wide range of conditions, and in offshore work it has been particularly useful for controlling visc, gel strengths, and filtrate loss with minimum dilution. Gypsum muds treated with the sulphonate are economical in preparation and maintenance and their properties are not strongly affected by salt or anhydrite contamination. Filtrate rate can be controlled by increasing the concn of the sulphonate or by adding carboxymethylcellulose. The mud has low alkalinity, which is useful for electric logging, and it is stable under high temp. pH control is important and the most suitable range is pH 8·5–10·0. A procedure for testing is given, and examples of field usage of the mud for several areas in Texas, Louisiana, Oklahoma, and Canada are included. C. A. F.

462. Study of the structure of clay suspensions in view of their use as drilling muds. M. Martin. *Rev. Inst. franç. Pétrole*, 1958, **13** (7–8), 1102–16.—After defining various terms which are of importance in discussing clays and clay suspensions, the structure of bentonites is described, including the crystallographic units and the nature of the forces believed to hold the plates together. Exchangeable ions are of importance in deciding the properties of the clays. Water can enter between the plates and can also become attached to outer surfaces. In aq media the clay plates have a negative charge on their surfaces with a diffuse zone of positive ions around them. Water molecules, because of their dipole moments, are orientated in relation to these positive and negative charges, giving the hydration. It is even thought that these orientated water molecules may link clay platelets. Strong electrolytes may suppress the ionization of bentonite suspensions.

Various means have been applied to studying the structure of the suspensions, including viscometry and the ultramicroscope. The latter has indicated that in gels the particles are grouped in aggregates at random. G. D. H.

463. Electric log interpretation. S. H. Southwick, J. K. Kerver, and W. O. Winsauer. *Oil Gas J.*, 17.11.58, **56** (46), 193.—A qualitative method of electric log interpretation is described which is applicable to both clean sands and shaly formations containing waters of high or low salinity. It is based on the equation:

$$SP = -0{\cdot}11\ (460 + T)\ \log a_w/a_{mf}$$

where SP is the self-potential shown on the log; T is the formation temp, °F; a_w and a_{mf} are the mean activities of dissolved ions in formation water and mud filtrate respectively. Nomographs constructed from this relation are provided, by which values of invaded zone and uninvaded zone resistivities (obtained from suitable electric logs) and of the mud filtrate resistivity are converted to the "resistivity index," *i.e.* true formation resistivity/resistivity formation would have if saturated with formation water. If this index is *ca* unity the formation is water-saturated; if the value is appreciably higher, hydrocarbons are indicated. J. C. M. T.

464. Velocity log characteristics. A. A. Stripling. *J. Petrol. Tech.*, 1958, **10** (9), AIMME Tech. Paper No. 8028, 207–12.—In velocity logging the measurement is of a travel time, which may include the path through mud to the well wall, as well as the path in the formation. The two-receiver device is more accurate than the one-receiver device, but the logs are almost the same when the hole is true to gauge. The radius of investigation depends on the wavelength of the impulse among other things, and is now between 0·75 and 7·5 ft. Filtrate invasion in a gas zone, if deep, will mask the presence of gas on the velocity log, but will not do so when invasion is shallow. The boundary between adjacent thick beds lies ½ the spacing from the point where the log first shows the influence of the second bed. However, examination of various combinations of thin (less than spacing) beds shows that there are cases where the log defines bed boundaries clearly, but in other cases the boundaries are obscured. Cavities cause log distortion, yet for the two-receiver device self-compensation causes the distorted readings to yield the correct vertical travel time. G. D. H.

465. Improved logging methods reveal productive zones. K. H. Schmidt. *World Oil*, 1958, **147** (6), 125.—Improved equipment is being used in mud logging which has increased the sensitivity of this method for detecting oil and gas shows. I.r. analysers, mass spectrometers, and gas chromatographs are being used quantitatively and qualitatively. A con-

trolled flow system is used in conjunction with the spectrographic equipment.

The detection of shows involves logging the mud stream and assumes that the potential pay yields some of its hydrocarbons to the return mud stream and the apparatus is used to extract hydrocarbons from the stream and to determine their amount. Limitations of the older equipment are noted and advantages of the new methods described. I.r. equipment can detect gas with a sensitivity of more than 50 p.p.m. The mass spectrograph has a sensitivity of 20–150 p.p.m., depending on the hydrocarbon constituents, and the gas chromatograph has a very high sensitivity ranging from 2 to 10 p.p.m. Anomaly rating is used as a basis for interpretation, the magnitude of the gas anomaly being related to the formation saturation. It has been found that highly permeable sands give large gas anomalies and it is possible to predict hydrocarbon-bearing beds which are free of producible water. C. A. F.

PRODUCTION

466. Some aspects of the mechanics of fluids in porous media. P. Alba. *Rev. Inst. franç. Pétrole*, 1958, **13** (7–8), 1117–56.—Various problems of the mechanics of fluids in porous media are reviewed and discussed with the use of tensor calculus and the Laplace transformation. Starting with Darcy's experiments, the Darcy law is examined, followed by consideration of the general equations for fluid flow in isotropic porous media, relationships governing flow and pressure in anisotropic media, and polyphase flow for non-miscible and for miscible fluids. The Navier–Stokes equations are applied to flow in homogeneous media. Flow through beds of fibres or spheres and through biconical channels is studied.

The diffusivity equation is used for various problems associated with radial flow, and these include pressure build-up on closing in a well and the influence of the well. G. D. H.

467. Time-cycle intermitters, plunger lifts boost output. A. J. Dudenhoeffer. *World Oil*, 1958, **147** (7), 101.—Intermitters and plunger lifts have been adapted to individual well requirements in the San Juan basin, New Mexico, and, with efficient techniques, production problems due to liq accumulations in the well bore and paraffin deposits in the tubing can be eliminated. The wells produce gas, mainly from the Mesa Verde sands from 4500 to 6500 ft, and liq production consists of dist, oil, and water. Intermitters are used for purging the well of accumulated liq, which are unloaded through a 1¼-inch siphon string.

Plunger lifts have been used successfully to boost production, with increases ranging up to *ca* 40%. The most useful type of installation consists of an arrangement whereby the gas is produced through the tubing string to a sales line at 500 p.s.i.g. The plunger in the tubing is controlled by a time cycle device, the interval between the movements being determined by trial and error. Diagrams show plunger-lift installations, and orifice meter charts, showing producing rates before and after intermitter and plunger-lift installations, are included. 7 refs. C. A. F.

468. How to calculate recovery from a gas reservoir. F. W. Cole. *World Oil*, 1958, **147** (6), 147.—Material balance can be used for a gas reservoir to determine: (1) original gas in place; (2) pressure–production history; (3) amount of recoverable gas; and (4) size of reservoir. Formulæ are developed, using the gas laws, enabling these quantities to be determined, and an example is given. C. A. F.

469. Calculating recoverable oil reserves. D. H. McLendon. *World Oil*, 1958, **147** (6), 119.—The classic formula for calculating oil reserves is presented which includes the following factors: porosity, oil saturation, formation vol factor, recovery factor, and thickness and acreage of the pay. The best methods for determining each of these is briefly noted and a nomogram is given for solving the formula. The producing life of the property can also be determined under the existing proration regulations, likewise the gross and net annual income from the property, assuming a salvage value for the equipment at the end of its producing life. 22 refs. C. A. F.

470. Relationship between the resistivity and chemical composition of brines. M. Martin. *Rev. Inst. franç. Pétrole*, 1958, **13** (6), 985–96.—Dunlap has proposed a series of coeff for the ions commonly present in brines which are mean values for conversion to the equivalent of Na or Cl, thereby permitting calculation of the resistivity of the brine. For given ion there is some variation of the coeff with brine composition.

The applicability of Dunlap's coeff has been investigated for different compositions, concn, and temp. Appreciable variations with concn were found, the values diminishing with rise in concn as theory would predict. The mobility of ions diminishes with increase in concn. At N/10 and N/100 the coeff are largely independent of temp, but for N the temp effect varies with the ion.

If i is the concn of an ion on g/l, and $I = [\Sigma i - (\mathrm{Na} + \mathrm{CL})]/\Sigma i$, then at 20° C, if $I < 0{\cdot}01$, ions other than Na and Cl can be neglected; if $0{\cdot}01 < I < 0{\cdot}1$, all the coeff equal 1; if $I > 1$, Dunlap's relationships apply. G. D. H.

471. Study of reservoir rocks by Regie Autonome des Pétroles. P. Alba. *Rev. Inst. franç. Pétrole*, 1958, **13** (6), 940–8.—It was decided to examine, in a central lab, porosity and permeability every 0·25 m, irreducible water saturation every 0·5 m or 1 m, and capillary pressure every 1 m. 1500–2000 porosity measurements were made each month using one engineer, two technicians, and six operators. Porosity measurements were made on the permeability specimens, which were 2·3 cm dia and 2·3 cm long, using saturation and immersion in mercury. Air was used for horizontal and vertical permeabilities. Capillary pressure curves were obtained by mercury injection, and irreducible saturation by evaporation. Relative permeabilities to the non-wetting phase were measured by the stationary liq method, whereas wetting phase relative permeabilities were derived from the capillary pressure curves. Colorimetric methods were used for rapidly obtaining oil saturations, or, in the case of sidewall cores, water extraction by xylene.

Preparation of the samples is described, together with details of the methods of measurement. Soxhlet extractors capable of taking 5, 10, or 40 plugs were used. 48-hr extraction may be needed when impregnation is high. Preliminary drying was by hot air currents. Pieces of core with a central hole were used when the rock type called for observations on larger samples.

Formation factors were obtained by a technique in which end effects were allowed for by using electrodes with brine separating them from the specimen, and also replacing the specimen by solution, or by a steel plug.

The cost of the studies seems to be *ca* 10,000 fr./m including transport. G. D. H.

472. Thermal recovery process—an analysis of laboratory combustion data. A. L. Benham and F. H. Poettmann. *J. Petrol. Tech.*, Sept. 1958, **10** (9), 83–5.—Combustion of the "coke" formed in the thermal recovery process will be defined by

$$\mathrm{CH}_n + \left[\frac{2m+1}{2m+2} + \frac{n}{4}\right]\mathrm{O}_2 \longrightarrow \left[\frac{m}{m+1}\right]\mathrm{CO}_2 + \left[\frac{1}{1+m}\right]\mathrm{CO} + \frac{n}{2}\mathrm{CO}_2$$

where m is the ratio of moles of CO_2 to CO produced. If Z is the coke in lb/cu. ft. of formation, Y the fraction of O_2 consumed in air, A the cross-section, and V_f the velocity of the combustion front in ft/hr then:

$$V_f = [0{\cdot}00109\,(12 + n)\,Y\,(\text{cu. ft. air/hr})] \Big/ \left[\frac{2m + 1}{m + 1} + \frac{n}{2}\right] ZA$$

Values calculated from this relationship agree well with the experimental data of Martin *et al* on a sand pack. Analysis of the observations suggests that there may have been channelling leading to low oxygen utilization. G. D. H.

473. Relationship between rate of return, payout, and ultimate return in oil and gas properties. C. E. Phillips. *J. Petrol. Tech.*, Sept. 1958, **10** (9), 26–9.—The earning power of invested capital has been assessed in various ways, and the rate of return method employs the interest rate that results in the discounted present worth of future net income being equal to the initial investment in the property.

If a property has a constant percentage decline a composite decline-discount factor can be used in calculations, and the cumulative present worth is equal to $[N_o(1 - e^{-kn})]/k$, where N_o is the instantaneous initial net income rate ($/year), n is time in years, and $k = a + j$, j being the discount interest rate and a (decline factor) $= -\ln R$, where R is yearly decline ratio. Trial-and-error calculations are needed when the decline rate changes. Allowance for future investment can be made by discounting back to the present.

The payout is given by $R^x = 1 - a\,C/N_o$, C being the cost of the project. The ratio of ultimate return to investment is $E/C = [k(1 - e^{-an})]/[a(1 - e^{-kn})]$, where E is the total future net income. The relationships between rate of return and other criteria are also presented. G. D. H.

474. Identification of mixtures of waters from chemical water analyses. J. C. McKinnell. *J. Petrol. Tech.*, Sept. 1958, **10** (9), 79–82.—For mixtures of two waters the two ionic analyses and the total salt content are plotted on vertical lines as equivalents per million, with the horizontal distance separating the two lines representing 100 parts of water. Straight lines are drawn connecting the values for each ion or the total, and the appropriate values for the mixed water are marked on each of these connecting lines. If there has been no base exchange or precipitation after mixing, the plotted points will lie on a vertical line, the position of which gives the proportions of the two waters involved in the mixture.

When three waters are involved basically the same type of plot is applied on a triangular prism, although for convenience the three vertical sides are opened out to a plane. Since the values for the mixture will occur on two of the three connecting lines, their positions are then plotted on the triangular base, and in the absence of disturbing effects all the lines, on transfer to the base, will intersect at a point which fixes the proportions of the three waters involved in the mixture. G. D. H.

475. Repressuring improves production in Mapiri field. G. J. Clarke. *J. Petrol. Tech.*, Sept. 1958, **10** (9), 35–7.—The U2 sand of the Mapiri field (Venezuela) is an Oligo-Miocene N.–S. channel-type sand, 60 ft thick in the centre and averaging 23·5 ft. It is variable, fine to coarse in grain, averaging 12% porosity, and ranging 20–2000 mD in permeability. Interstitial water is 20% and the initial gas cap was *ca* $\frac{1}{5}$ of the 600-ft oil leg. The solution G.O.R. was 950 at 4100 p.s.i., the formation vol factor being 1·669. Volumetric estimates gave 30×10^6 brl of oil in place. Solution gas drive is the main producing mechanism; edge-water drive is absent. For abandonment at 1500 p.s.i. with a producing G.O.R. of 11,500, 19·6% recovery was predicted. Output had fallen from 4400 to 2000 b.d. (1500 G.O.R.) when gas injection began in 1954. At the end of 1957 11,078 M.M.c.f. of gas had been injected, raising the pressure from under 3000 to 4100 p.s.i. with production of 2,083,000 brl of oil, compared with 3,400,000 brl before injection began. The G.O.R. rose to 3000 in 1956, and then fell to 1000 late in 1957. All wells except one were flowing strongly at the end of 1957. A final recovery of 32·4% is expected. G. D. H.

476. Are we making water systems too complex? H. L. Bilhartz. *J. Petrol. Tech.*, Sept. 1958, **10** (9), 13–16.—A desirable water is readily accessible, cheap, available in sufficient amounts, and compatible with other make-up waters; it need not be compatible with water in the formation, free of H_2S, or of perfect quality.

Produced and make-up water should be considered together in designing plant, and recognition of possible variations in individual amounts over time is important. Flexibility is required. The closed system is simpler, and is usable with shallow water sands, subsurface make-up brines, and produced water. Open systems are needed for surface supplies.

Undue emphasis is often placed on the presence of sulphur bacteria. Design can take care of some types of corrosion if replacements are simple to make. Continuous or almost continuous operation will avoid overloading of filters. When two types of water have to be handled, an open and a closed system may be needed, and arrangements can be made for gradual switching of some facilities as the water ratios change. An overall evaluation is best for water quality control, and it is necessary to realize that there may be changes over time. G. D. H.

477. Importance of economics in production and reservoir engineering. T. C. Frick. *J. Petrol. Tech.*, Sept. 1958, **10** (9), 11–12.—Profitability is a guide in making business decisions, but not all agree on how to determine profitability. Profit itself has several meanings. Capable engineers may reach markedly different conclusions about costs. There are various reasons for undertaking projects, and for the timing; the purpose may be one of the factors indicating the method. There is much to be said for wider well-spacing. Labour-saving devices are important. Contractual and other obligations may be at variance with simple technical or economic considerations in the matter of drilling some wells. The cash available and the income tax position influence some decisions. G. D. H.

478. Effect of taxation on valuation and production engineering. C. W. Breeding and J. R. Herzfeld. *J. Petrol. Tech.*, Sept. 1958, **10** (9), 21–5.—Taxes are important in evaluating an investment, and therefore the tax laws applicable to various situations are of special interest. Prior to 1954, when it became possible to elect to aggregate operating mineral interests forming all or part of a single operating unit, tax law required that each interest should be treated separately for tax purposes. The depletion allowance permits a tax-payer to make a reasonable deduction for the estimated cost of reserves exhausted. Lease bonuses or purchase prices, various fees connected therewith, and geological and geophysical expenses incurred in acquiring or retaining a property interest are capitalized. Expenditures on tangibles are also capitalized and recovered by depreciation allowances, whereas costs of intangibles are either expensed or recovered by depletion. The election to expense intangibles must be made in the first taxable year.

Various transactions are commonly made to share risks and rewards, and these comprise lease or sub-lease, sale or exchange, anticipation of income, and sharing arrangements.

In order to illustrate some of the fundamental concepts, a few specific transactions relating to unproven and developed properties are discussed. G. D. H.

479. Spacing of natural gas wells. R. C. Grange. *J. Petrol. Tech.*, Sept. 1958, **10** (9), AIMME Tech. Paper No. 8029, 213–19.—Field evidence from sand reservoirs in Texas and

also from limestone reservoirs shows clearly that there is interference between gas wells and in some cases between gas pools over considerable distances, at times of the order of tens of miles. In some fields undoubtedly more wells have been drilled than are basically needed, and sound conservation practices are not being obeyed.

In addition to acting as outlets for gas, wells provide data on the form and properties of the reservoir and serve as a means for controlling the natural or induced recovery mechanism. Beyond the number needed for these purposes, which include the required producing rate, additional wells do not increase the recovery. The initial wells should be widely spaced and aimed at acquiring the data needed for making a sound decision on the appropriate spacing. G. D. H.

480. *In situ* combustion. J. S. McNiel and J. T. Moss. *Oil Gas J.*, 15.9.58, **65** (37), 232–41.—Thermal methods of oil recovery rely on the facts that temp increase gives a notable reduction in the oil–water visc ratio, and if in addition the temp is raised enough to vaporize the interstitial liq displacement efficiency should approach that of miscible-phase processes. *In situ* combustion is the most efficient way of supplying the heat. Fuel consumption is 1–2 lb/100 lb of reservoir sand, air requirements 200–400 cu. ft/cu. ft. sand for 100% oxygen utilization (actual utilization is lower, perhaps 90%). Heat transfer outwards from the combustion front is by conduction assisted by the steam and hot water produced by combustion and by vaporization of formation water, while light hydrocarbons due to dist and cracking of the crude blend with the formation oil and increase its mobility. The zone of high oil saturation which results constitutes the " oil bank," which moves ahead of the combustion zone. The residual coke provides the principal fuel burned, and the clean hot sand left behind pre-heats the combustion air. Combustion temp are *ca* 600°–1200° F. Rate and direction of movement of heat front need careful control, but complete success in this has not yet been achieved. The pattern of areal sweep is such that at break-through of burning front into production wells *ca* 62% of the well-pattern area is swept. The vertical sweep is at present unpredictable. Experiments on *in situ* combustion date back to 1938 in Russia. 26 refs are given.

J. C. M. T.

481. Calculating bottom-hole pressures. L. L. Hurst and E. T. Guerro. *Oil Gas J.*, 29.9.58, **56** (39), 79–86.—A modification of the Horner method of calculating static bottom-hole pressures from pressure build-up data is developed, involving a correction factor which reduces the error in most cases. The final error is within the accuracy of present bottom-hole pressure measurement. Curves necessary for determining the correction factor are provided.

J. C. M. T.

482. Gas reservoir material balance can be helpful. F. W. Cole. *World Oil*, 1958, **147** (5), 182.—For a closed gas reservoir with no water influx, a material balance can be equated as follows:

$$G\left(\frac{1}{v_o}\right) = V_g + G\left(\frac{1}{v}\right)$$

where G = reservoir gas space, brl; v_o = gas conversion factor at original reservoir temp and pressure, brl/standard cu. ft.; v = gas conversion factor at any later pressure and temp, brl/standard cu. ft.; V_g = cumulative gas produced, standard cu. ft. This can be rearranged to solve for G, the gas conversion factor v being derived from the gas laws. The accuracy of G will in general increase with increasing cumulative production.

If there is water influx a material balance equation can be developed in a similar way, and it can be shown that

$$W = V_g v + w - G\left(\frac{v}{v_o} - 1\right)$$

where W = gross water influx into the reservoir, brl; w = water production, brl.

This equation is useful for determining the additional reserves due to the water drive and for measuring the rate of change of the gas–water contact. C. A. F.

483. Temperature logs aid gas storage well analysis. J. M. Bird and J. C. Dempsey. *World Oil*, 1958, **147** (7), 128.—Temp logs can be used quantitatively for determining, in a flowing gas well, the relative amounts of gas flowing from each zone, as well as for indicating the positions of the pays. The formula for determining these quantities is given, and it is claimed that characteristic and repeatable log patterns have been obtained for different conditions in gas storage wells.

For the log to be valid, the well must have reached thermal equilibrium, 3–4 hr usually being sufficient.

Logs taken under static conditions can be used for detecting leaks, thief zones, channelling, or migration from one zone to another. Examples of temp logs are given. C. A. F.

484. Progress in the development of sucker rods for oil-well pumping. Pt 2. L. C. Uren. *World Petrol*, 1958, **29** (11), 54.—In designing sucker rod strings max efficiency requires careful analysis of stresses and other factors which determine the size and quality of rods to be used. The elastic limit of the steel will determine the theoretical max working stress, but fatigue can cause a lower limit in service. With common rod sizes of $\frac{5}{8}$–1 inch, max peak load would be 8000–24,800 lb. Rod partings are usually due to joint failures, due to pin breakage at the root of the first full thread where fatigue stress is often concentrated. This hazard can be met by secure make-up of the joint and increasing tensional stress in the pin. In selecting steel for sucker rods, ductility and elasticity must be considered; a ductile steel resists better rapid stress changes, and elasticity promotes proper plunger strokes in deep wells. Tapered rod strings enable excessive stress to be combated with economy, and hollow rods have been used locally where their greater buoyance helps to reduce string load.

Well-head measurement of rod stresses using a dynamometer is recommended, and the life of rods can be increased by using corrosion inhibitors such as sodium chromate, antimony and arsenic salts, formaldehyde, and cyanamides. Balancing loads can reduce rod vibration, and a recording tachometer is useful for adjusting counterbalances.

Factors to be considered in selecting appropriate size of pump plunger to avoid overstressing of sucker rods and the adjustment of time and length of stroke of rods to give max pump efficiency and minimum rod stress are noted.

C. A. F.

485. Determine the size of a gas reservoir. F. W. Cole. *World Oil*, 1958, **147** (7), 158.—The approx number of acres occupied by a gas reservoir can be computed from the material balance and volumetric equations. These are given, and it is emphasized that the accuracy increases as more production data become available. It is particularly useful when a well has been drilled into a new gas reservoir whose size is required for determining the future drilling programme. An example is given in which it is shown that an error of 3·6% in the measurement of reservoir pressure gave an error of 248% in the calc areal extent of the reservoir. C. A. F.

486. Intermittent gas lift operation is successful for two-string duals. W. P. Massey. *World Oil*, 1958, **147** (7), 108.—Intermittent gas lift has proved successful in dual completion of a near-stripper well in W. Texas. Gas injection was controlled by a regular time cycle controller, also controlling a motor valve on each flow line. The valves are normally open, permitting static build-up of each zone between the injection phases. A diagram shows the mechanism of the cycle and intermitter.

The intermitter valves are retrievable on wire-line, and the depth of the lower zone is usually several hundred feet below the upper. Isolation between the zones is effected by using two packers.

Dual completion with gas lift can now be made in 5½-inch casing using two strings of 1½-inch tubing, or one of 1½-inch and the other of 2$\frac{1}{16}$-inch. In 7-inch casing two strings of 2-inch tubing can be used. The method of dual gas lift could now be extended to triple or quadruple completions.

C. A. F.

487. Neutron logging of flowing wells detects gas caps and high G.O.R. zones. R. G. Norelius. *Petrol. Engr*, 1958, **30** (12), B72.—Locating points of gas entry in flowing wells by means of a neutron log is a comparatively recent development, and from the beginning the method has been successful. Field tests have indicated that a properly run and properly interpreted flowing neutron log can locate points of gas entry in a flowing well nearly every time.

The presence or absence of hydrogen governs the response of the neutron detector, and consequently the quantity of hydrogen in formation fluids and the borehole is of importance. A flowing neutron log locates the point of gas entry because of gas within the well bore and not because of the presence of gas in the sand. Charts included in the paper show the effect of subsurface ratio of oil to gas on neutron amplitude for sands of various porosities in a water-filled uncased hole. M. F. M.

488. Sahara oil search gathers momentum. V. S. Swaminathan. *Petrol. Engr*, 1958, **30** (11), B47.—The first strike in N. Africa was made in the Edjele area at the beginning of 1956, and by the end of June there were 25 producing wells (all shallow). A second important strike was made at Hassi Messaoud at deeper levels (exceeding 8000 ft), where exceptionally high pressures were encountered. Ten wells are now producing in this area. Reserves at the latter area are placed between 600 million and 800 million m. tons. The oil-bearing zones lie at depths of between 10,000 and 11,000 ft and are 300–450 ft thick.

Both French and foreign companies have interest in the Sahara oil. At present much of Central Sahara, including the Hassi Messaoud oilfield, is held by two French companies, namely, the Compagnie Française des Petroles "Algerie" (C.P.A.) and the Société Nationale de Recherche et d'Exploitation de Pétroles en Algerie (SNREPAL).

The article gives the detailed financial set-up and the interrelations of French and foreign companies interested in the exploration and exploitation of oil from the Sahara.

M. F. M.

489. In North Texas Strawn hydraulic fracturing pays off. T. M. Garland and W. C. Elliott. *World Oil*, 1958, **147** (6), 155.—The results are described of a study by the U.S. Bureau of Mines of the effects of hydraulic fracturing on oil recovery from the Strawn of N. Texas. It was found that, over a period of 24 months following the treatment, total monthly production from 69 wells increased from 18,400 to 45,100 brl, or 2·45 times monthly production before treatment. During the first six months after treatment, average production increase was 150%. In approx 71% of the wells, decline rate, after successful treatment, was equal to or less than the pre-treatment rate. Treatment was most successful in wells in which reservoir energy had not apparently declined, and large treatments generally gave large increases in production rate. Treatment of specific intervals of the productive zone appeared to give more satisfactory results than overall treatment, and in wells previously shot with nitroglycerine the results of treatment were not so marked.

The Strawn formation produces from sands varying in thickness and lithology; permeability is usually low. Tables and charts summarize the results of the survey. C. A. F.

OILFIELD DEVELOPMENT

490. Deep drilling and extensions may increase potential of Nesson Anticline area. D. D. Dallas. *World Oil*, 1958, **147** (7), 148.—Most of the production from the Williston basin in N. Dakota comes from the Nesson Anticline, where approx 75 miles are almost continuously productive. The main producing formation is the Mississippian Madison limestone, but it is expected that, in future extensions, the Devonian, Silurian, Ordovician, and Cambrian will also produce.

There is heavy drilling activity in the area, and there are approx 1100 producing wells in the state. Typical drilling and completion programmes are given for Madison wells, and economic and transport facilities are briefly outlined.

C. A. F.

491. Economics of secondary recovery in Montana. D. H. Harnish. *World Oil*, 1958, **147** (6), 107.—Cumulative production in Montana to the end of 1957 was *ca* 276·7 million brl, and daily production is now at a peak of 75,000 brl, the increase being due mainly to the development of the Williston basin area. The older "stripper" fields in the region are declining, with many near their economic limit, but it is suggested that if secondary recovery methods can be used in these fields there could be a substantial further increase in Montana's production. 22 of these fields have been studied, and it has been estimated that their secondary recoverable reserves amount to *ca* 327,700,000 brl. There are limestone and sandstone reservoirs, but evaluation will be difficult because of the paucity of reservoir data. It is emphasized that the secondary recovery programme should be started as soon as possible, before many of the producing wells are plugged and abandoned, and it is concluded that Montana's reserves could be approx doubled by successfully applying secondary techniques, obtaining a gross income of some $1 billion (assuming an average of $2·85/brl gross for the secondary recoverable reserves). Direct taxes to the state of Montana would approximate $60 million (based on 18 cents/brl).

C. A. F.

492. North Tejon shaping up as major high gravity field. W. H. LeRoy and J. P. Lavery. *World Oil*, 1958, **147** (5), 214.—The N. Tejon area in the SE. San Joaquin Valley, California, promises to become important as a source of high gravity oil. The limits of the productive area have not yet been defined. Pays range from 9500 to *ca* 12,500 ft in depth, and the structure is said to be an E. plunging nose with complex faulting, the main accumulation control being apparently an updip permeability barrier. Production is from Lower Miocene Vedder sands, and average producing interval, which varies from well to well, is 400–500 ft thick. A typical completion and drilling programme is given. A thick volcanic section which contains bentonite streaks causes drilling problems because of sloughing of the hole and the risk of pipe sticking. C. A. F.

493. New fields boost Canada's natural gas reserves. J. Stabback. *World Oil*, 1958, **147** (7), 162.—Reserves of gas in W. Canada at the beginning of 1958 were estimated at 23·6 trillion cu. ft., and discoveries and developments during the year have increased this to over 25 trillion cu. ft. Ultimate recoverable reserves for the area are estimated at over 250 trillion cu. ft., of which Alberta would contribute 90 trillion cu. ft. Methods of estimating these reserves are outlined, together with the method of predicting ultimate reserves statistically.

Gas was first found in 1883 at Alderson in Alberta, and there is now production also from Saskatchewan and British Columbia. No significant gas fields have been found in Manitoba, Yukon, or NW. Territories. The last two states are rela-

tively unexplored, but there should be significant finds in the future. 7 refs. C. A. F.

494. Intensified search in South America. Anon. *Petrol. Press Serv.*, 1958, **25**, 255–8.—Venezuela excepted (see *Petrol. Press Serv.*, 1958, **25**, 124), oil exploration in S. America has been confined to a few potential oil lands. Public opinion—hostile to foreign oil companies—and lack of finance and local skill where state entities have been set up have hindered exploration. Private companies holding concessions have encountered many discouraging factors. The position—changed in recent years—shows a desire in most S. American countries to develop petroleum resources, in view of their economic growth and the need to meet payment balances of the rising oil imports needed to meet the ever-growing consumption of petroleum products. Excepting Uruguay, Paraguay, and the Guianas, every S. American country has oil production, and some have introduced new legislation permitting concession granting to foreign companies. Many foreign oil concerns, especially American, have taken up territory. The 1955 amendments to the oil laws have stepped up exploration in Colombia. Bolivia is being developed by YPFB, the state oil entity. In Brazil exploration is in the hands of Petrobras, the state-owned entity. Exploration in the Amazon basin is being intensified (see *Petrol. Press Serv.*, 1958, **25**, 186). In Argentina, since the passing of the 1935 law, exploration in new areas is confined to the state oil entity YPF. With a trade deficit of $350 million, special bonds are being issued, and foreign operators are invited to tender for work for YPF (see *Petrol. Press Serv.*, 1958, **25**, 147). Exploration in Chile has been checked by the limited resources of ENAP, the state concern with a monopoly. Peru, the oldest oil producer in S. America, has long sought to attract exploration activity in the interior. Uruguay—state oil concern ANCAP—Paraguay, and British Guiana are small producers. R. T.

495. Active oil exploration is proceeding in Afghanistan. Anon. *World Oil*, 1958, **147** (6), 175.—There have been significant oil developments in Afghanistan during the past year. New legislation for the industry has been drafted and reconnaissance exploration has been carried out. Drilling commenced in 1956 near Sar-i-Pul, and two wells have had oil and gas shows. There is stiff competition between the U.S.A. and Russia in the development of the country's natural reserves. C. A. F.

496. Oil in Siberia. G. G. Rosu. *World Petrol.*, 1958, **29** (11), 48.—The need for additional oil in European Russia has led to serious exploration in Siberia during the last five years, and important mineral reserves have been found. The Ural–Volga region is expected to remain the largest producing area for some time, but there should be increased production from Turkmen, Kazakh, and Kirghiz. The rapidly expanding economy of Soviet Asia has required a new oil supply pattern, and pipelines have been built. The main route comprises a set of pipelines running from the Ural–Volga region along the S. Siberian border.

Production from local areas is being intensified, and surveys are being carried out by various geological groups. Most of the Siberian platform consists of sedimentary basins, and during the past four years rich gas fields have been found in W. Siberia at Berezovo on the Lower Ob, Tyumen on the Tobol river, and at Kolpashevo in the Tomsk area. In E. Siberia there are several oil basins, and salt domes are known; the Kamchatka peninsula, where the Tertiary is thick, is a promising region. C. A. F.

TRANSPORT AND STORAGE

497. Tanker heating coils. Anon. *Fluid Handl.*, 1958, 337–40.—Essentials of tanker heating coil installations are listed. Mild steel, cast iron, Al brass, and Al alloy tubes of conventional grid patterns are considered, and their good and bad points enumerated. Descriptions are given of recently introduced helical coil units and portable heating grids. W. A. M.

498. The submarine tanker. Anon. *Petrol. Press Serv.*, 1958, **25**, 178–81.—Great Britain, the U.S.A., and Japan are examining the potentialities of nuclear submarine tankers. The outstanding attraction of under-water merchant ships—provided they are atom-powered—is their unrivalled speed performance on a given engine power, due to greatly reduced hydrodynamic resistance compared with that of surface ships. Reduced submarine speed from 15 to 20 knots at surface cruising to <10 knots submerged results from power transfer from diesels to batteries. A submarine tanker may be tailored more closely to hydrodynamic rules, a naval craft must be subordinated to its overriding function as an instrument of war. Under-water endurance of a conventional submarine is limited by the necessity for surfacing for battery recharging by the diesel engines. A nuclear reactor does not need air for generating or refuelling for a year or two. Thus it can operate continuously with equal efficiency on the surface or submerged for an indefinite time. The U.S. *Triton*, a twin-screw atomic submarine, is designed for under-water speeds up to 30 knots, surpassing the current 17·5-knot max of the fastest supertankers. Marine engineers apparently are thinking of 50 knots, where power required would be *ca* 500,000 kW = 670,000 h.p. from a single reactor. To produce the high speeds submarine tankers could be streamlined to suit total water depth available, immersion depth, vessel's size, propeller efficiency, and operational speed. The U.S.A. probably will power its atomic submarines with the pressurized water reactor which uses expensive enriched uranium fuel. The U.K. reactor burns cheaper natural uranium. Entirely new techniques will have to be evolved for controlling ballasting and buoyancy during submersion and ascent, navigating at depth, manœuvring through shallower coastal waters, for loading and discharging cargoes, and changing crews. R. T.

499. Interface detectors: progress but not perfection. R. R. Hancox. *Oil Gas J.*, 15.12.58, **56** (50), 119.—The results are given of five years investigations by Great Lakes Pipe Line Co. into problem of interface detection when transporting refined petroleum products. Types of interface considered are fuel oil–fuel oil, gasoline–fuel oil, and gasoline–gasoline.

The first two are relatively easy to detect, but gasoline–gasoline interfaces present difficulties.

Statistical analysis of density, dielectric constant, loss factor, and index of refraction indicated latter should give higher probability of detecting interface.

Capacitance instrument tests gave advance warning of *ca* 6–8 minutes when detector was located *ca* 2000 ft upstream from station. When interfaces have travelled 200 miles or more, interfaces are quite diffuse and provide less definite signals.

Problems involved include electrical noises, impossibility of detecting 100% of interface, and difficulty of interpreting complicated signals.

Present work includes comparison of resonant frequencies of two circuits and use of flagging material. G. A. C.

500. Cold bending by sideboom. J. W. Jones. *Petrol. Times*, 2.1.59, **63** (1602), 9.—AD-7 sideboom tractor was modified to make a series of bends in pipelines for a project in the Middle East. Permissible error was 1°, and bends had to be of short radius type. The modified boom consisted of two vertical legs made of heavy section material, and a fully segmented bending shoe was manufactured from 16-inch pipe.

Force for bending was applied through load line and pipes of random length from 20 to 42 ft successfully dealt with, the smallest bend being 14° and greatest 52°. G. A. C.

501. World's longest gas line—Trans-Canada—is completed. L. O. Rowland. *Petrol. Engr*, 1958, **30** (12), D24.—The world's longest natural gas pipeline has now been completed for its entire length of 2200 miles from the Alberta–Saskatchewan boundary to Montreal. This is the system of Trans-Canada Pipe Lines Ltd. Five compressor stations have been installed as the first stage. Three large identical stations have been constructed at Burstall, Caron, and Moosomin and are each equipped with three 3400-h.p. engines. The fourth station, of 7500 h.p. capacity, is at Ile des Chenes, Manitoba, where the 34-inch line steps down to 30-inch line. The last compressor station is at North Bay, Ontario, where there are three 1800-h.p. units and the station is equipped to send gas in either direction, thus providing flexibility of operation. M. F. M.

502. Computers analyse economic feasibility of proposed pipelines. T. R. Young. *Petrol. Engr*, 1958, **30** (11), D24.—The problem of pipeline investment analysis is complex and inherently active because old sources of crude deplete and new ones are discovered. Assumptions must be made for unit costs of construction and operation, line route, crude properties, tax rate, amount, and repayment schedule for borrowed capital, etc.

An analysis will usually include a computation of capital outlay, cash return, payout period, and yield on investment. It is often desirable to compute the data for each year of the projected life of the proposed line. As these computations demand weeks of manual labour, the computer has been used to shorten the study time for such analysis. A number of programmes have been written to handle different portions of the computation. Basically the work is divided into pipeline design, capital and annual operating cost estimates, and financial computations. Wherever practicable, the output from one programme is coupled with the subsequent programme by common punched card format.

Benefits achieved with automatic computation include proof that simulation of pipeline operation is practical. Such simulation is now being extended to the scheduling of oil movements and operational control. The computer has facilitated the extension of economic analysis, and a larger number of economic variables can be evaluated by other than manual methods. M. F. M.

503. Storage at Lussagnet: economic aspects. M. Socrate. *Bull. Ass. franç. Tech. Pétrole*, Sept. 1958, (131), 479–93.—Lussagnet is 53 km N. of Lacq. An early well had shown a highly permeable sand horizon with 200–300 m of impermeable cover. Five holes were drilled to confirm the desirable features, and then 22 km of 6-inch line and a compressor station and other facilities were installed in the summer of 1957. Seismic work indicated the absence of a fault, and three more wells were drilled. Withdrawal tests of 100,000–200,000 m³/day/well were made, and pressure stabilization was investigated for a month. Early in 1958 12 wells were drilled, and more gas injected.

It is thought that there will be no adverse chemical reactions during storage.

The surface equipment is briefly described. Steps are taken to avoid clogging of perforations or formation in injection, to prevent sand movement and hydrate formation. Expansion over the next two years is planned. Costs are discussed, together with other aspects of the gas storage project and its purposes. G. D. H.

504. Gas storage at Lussagnet: knowledge of the structure. M. A. Chaillous. *Bull. Ass. franç. Tech. Pétrole*, Sept. 1958, (131), 495–514.—Drilling and seismic work in order to define the Lussagnet structure showed it to be *ca* 4 km long, and 2 km wide at the 1–525-m contour, and seismic data suggested that a flexure or fault might give the limit of closure at 1–550 m. A clay–marl complex with some limestone intercalations provides cover. The reservoir is a sand, probably of lacustrine or fluviatile origin, with as much as 15% clay in the upper part. Porosity ranges 15–35%, with permeability *ca* 100 mD in the clayey sectors, and tens of darcys in the clean sands. Interstitial water amounts to 20–40%. With the water level at 500 m the storage would be *ca* 8×10^9 m³ of gas.

Some completions have been made with gravel packs to retain reservoir sand. Gas injection began in Sept. 1957, and there were short periods of withdrawal. Some wells are capable of giving 200,000 m³/day for a draw-down of some 4 kg/cm². It has proved possible to produce at considerable rates from relatively near the water without harmful coning. When *ca* 3×10^9 m³ of gas was in place withdrawal at 5×10^6 m³/day for 15 days caused a pressure drop of 10 kg/cm² (with no water drive a drop of 15 kg/cm² would have been expected).

10 wells, 150 m apart, are planned for the initial phase of injection, with crestal completion in clean sands in the upper part of the reservoir series. Ultimately there may be 35 wells with a capacity of 5×10^6 m³/day. G. D. H.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

505. How Conoco treats waste water. C. D. Hull. *Oil Gas J.*, 8.12.58, **56** (49), 73.—Continental Oil Co's refinery at Ponca City, Oklahoma, includes holding ponds of a total of 6·8 million gal capacity for waste water treatment, together with a steam stripper and biological oxidn units. The holding ponds permit efficient settling of suspended solids in effluents. Weak caustic solutions are neutralized if necessary with sulphuric acid in the ponds, and pH is controlled at or below 8·2.

Ammonia is removed by increasing tower temp and reducing pressure. Phenols are removed or consumed by the biological oxidn plants, one using a trickling filter and the other the activated sludge system. G. A. C.

DISTILLATION

506. Fractional distillation and mass transfer between liquid and vapour phases. E. Chahvekilian. *Rev. Inst. franç. Pétrole*, 1958, **13**, 782–839, 997–1020.—First part of this thesis deals with the laws of mass transfer between liq and vapour phases under the following headings: the problem of enrichment in fractionating columns, eff of fractionating columns using standard mixtures, factors affecting the eff of fractionating columns. In the second part these laws are applied to the practical case where hold-up is not negligible

and operation is not adiabatic, these factors being considered separately. W. A. M.

507. Estimate efficiency in mass transfer. J. D. Osburn. *Chem. Engng*, 1958, **65** (24), 119–22.—When designing equipment for stage contacting, the number of theoretical stages is first calculated. The second step is the estimation of stage efficiency, and this is just as important as the first one for correct design of a plant. In this article methods of calculating stage efficiencies for bubble-cap and sieve-plate columns for dist and gas absorption are reviewed.

For a bubble-cap column three different efficiencies are commonly used. These are overall column efficiency, plate efficiency, and local or point efficiency. These efficiency concepts are defined, and O'Connell's approx correlation of column efficiency with relative volatility of the key component and the feed visc is discussed. To find the number of actual plates the knowledge of plate efficiency is essential, and the latter itself is dependent on point efficiency. The relationship between these two efficiencies depends on three factors: (1) slope of the equilibrium curve; (2) ratio of gas to liq flow rate; and (3) fraction of liq mixing on the plate. Oliver and Watson's equation relating the two efficiencies is given and its application demonstrated by means of an example.

Entrainment lowers the efficiency, and its effect can be estimated from Colburn's equation:

$$E_W = \frac{E_D}{1 + e\,E_D}$$

where E_W is the wet efficiency, E_D the plate efficiency without entrainment, and e the entrainment rate. The knowledge of residence time and froth height on plates is also of importance in the estimation of efficiency, and here the application of methods developed by Geddes for calculation of point efficiencies from hydrodynamic and mass transfer theory is discussed. M. F. M.

508. Three-stage unit improves crude split. C. W. Wharton and E. P. Hardin. *Petrol. Refin.*, 1958, **37** (10), 105–8.—A 100,000-b.d. dist unit is being constructed at the Beaumont, Texas, refinery of Magnolia Petroleum Co. and will replace seven smaller units. This unit consists of one atmospheric crude dist tower, two vacuum towers in series, a gasoline rerun tower, and a stabilizer. Data presented indicate that a lower manpower per unit size and a higher productivity per operating man is achieved. Sharper atmospheric fractionation within the crude tower results in greater ability to shift product yields to meet processing demands. Improved vacuum fractionation results in increased yield of lub oils and wax. Operation of two vacuum towers in series is the most attractive way to attain the required fractionation. A summary of product flexibility for the old and new units is presented which is of interest. M. F. M.

SPECIAL PROCESSES

509. Newest sulphur recovery process. F. M. Townsend and L. S. Reid. *Petrol. Refin.*, 1958, **37** (11), 263–7; Anon. *Petrol. Engr*, 1958, **30** (11), C27.—An efficient process, with low costs to build and operate, for the removal and recovery of sulphur in natural gas has been discovered and named the "Townsend Process." The reaction mechanism is

$$2H_2S + SO_2 = 3S + 2H_2O$$

It provides for the simultaneous sweetening of sour gas and the conversion of H_2S to water and elemental sulphur, and is claimed to be insensitive to CO_2 in the process stream. The process is adaptable to a wide range of H_2S concn in the gas stream, and has a recovery efficiency of more than 95%. Cat and reaction medium is either tri- or diethylene glycol.

Cost and operating studies are still in early stages, and full evaluation of economic aspects in a pilot plant or semi-commercial unit is planned for near future. M. F. M.

510. How to separate xylenes for profit. J. A. Weedman and R. A. Findlay. *Petrol. Refin.*, 1958, **37** (11), 195.—During the past few years the commercial production of *p*-xylene has become widespread, and much work has been done on the separation of the xylene isomers. Upgrading of mixed xylenes into petrochemical intermediates can be achieved by a number of methods, depending on which individual xylenes are to be produced. These are: (1) superfractionation in towers with up to 350 trays for *o*-xylene and ethyl benzene; (2) ordinary crystallization at low temp for *p*-xylene manufacture; (3) adductive crystallization using either mol cpds or clathrates to yield more *p*-xylene or to make *m*-xylene in high purity; (4) extractive crystallization for the same purpose; (5) selective chemical methods such as HF–BF_3 extraction; (6) ordinary crystallization plus superfractionation for *m*-xylene manufacture. The Phillips continuous crystallization method readily produces 98–99% pure *p*-xylene, and superfractionation can be used to make the others in equivalent purities. M. F. M.

511. Ion exchange—a versatile processing tool. J. W. Churchman. *Petrol. Engr*, 1958, **30** (12), C41.—Ion exchange can now be compared with such unit operations as dist, fractional crystallization, and solvent extraction in many areas of process application. It can be used in such processes as the removal of copper from gasoline or elimination of acidic cpds, such as mercaptans, from petroleum dist. However, purification is the major area of application for ion exchange. This can be divided into two categories: (1) removal of cations or anions and neutralization; and (2) deionization.

Since ion exchange resins may be considered as insoluble acids or bases, they may be expected to promote reactions catalysed by aq sol of acids or bases. Advantages of ion exchange cat are ease of cat separation after reaction completion, substantial reduction, or complete elimination of side reactions and reduction of costs. A major disadvantage is the thermal limitations. M. F. M.

512. Nuclear radiation in chemical processing. F. T. Barr, H. J. Ogorzaly, and T. A. Reiter. *Petrol. Engr*, 1958, **30** (12), C48.—This paper is devoted to the use of radiation for improving process reactions by acting as initiating agent, and covers the subject in three sections, commercial sources of radiation, limitations of its use, and the cost of radiation for processing operations.

Radiation in large quantities is now available as γ-rays from radioisotopes, electron beams from accelerators, and fast neutrons and γ-radiation combined from nuclear reactors. The most important radioisotope source at present is Cobalt 60.

The paper gives a brief description of nuclear reactors (liq phase and vapour phase) which can be used for process radiation and also the activation limitations. Many applications have been suggested for radiation processing, some of which are: promotion of cracking at lower temp and pressures than is possible in the absence of radiation, chemical stabilization of dist, sweetening, increasing speed of combustion in rocket and jet engines, activation of cat (*e.g.* for hydrocarbon synthesis), preparation of stable coal-in-oil dispersions for use as diesel fuel, production of pour point depressants and V.I. improvers, and a number of others. M. F. M.

PRODUCTS

CHEMISTRY AND PHYSICS

513. Relation between the resistivity of waters and their chemical composition. M. Martin. *Rev. Inst. franç. Pétrole*, 1958, **13**, 985–96.—Resistivity of oilfield water is important but cannot always be measured directly. Dunlap's method (*J. Petrol. Tech.*, 1953, **3** (3), 17) for calculating resistivity from chem composition is based on empirical coeff relating mobilities of Ca^{++} and Mg^{++} to Na^{+}, and of SO_4^{--}, CO_3H^{-} and CO_3^{--} to Cl^{-}. These have been verified, and it is shown that at ambient temp calc and determined results are in reasonable agreement. Below 0·1N temp does not affect coeff; at higher concn effect of temp depends on ions present. Limits of applicability of Dunlap method are given. W. A. M.

514. Micro sample introduction system for gas chromatography. R. L. Bowman and A. Karmen. *Nature, Lond.*, 1958, **182**, 1233.—The liq sample is drawn into 1-cm lengths of 0·1 mm i.d. glass tubes by capillary attraction and the ends are sealed. The vol is determined by measuring the length of the sample liq. The tube is dropped on to a slotted plate at the top of the column through a suitable air lock, and crushed by means of a steel piston sliding in a polytetrafluoroethylene gland. A device for introducing the sample into the column and then crushing it is described. H. C. E.

515. Coalescence of liquid drops at oil–water interface. L. E. Nielson, R. Wall, and G. Adams. *J. Coll. Sci.*, 1958, **13**, 441–58.—Measurements were made of the length of time that single drops can exist at an oil–water interface before coalescence takes place with a bulk phase of the same composition. The effect of stabilizing agents soluble either in the oil or the water phases was investigated. Factors investigated included: temp; drop size and curvature of O/W interface; O/W *v.* W/O drops; type of oil; mutual solubility of oil and water phases; type, concn, pH, interfacial visc, and rigidity of stabilizing agent.

The stability of drops decreases as the temp is raised, and is affected by both oil and stabilizing agent. When the latter is water-soluble, oil drops are generally more stable than water drops, and vice versa. Mutually saturated oil–water phases form more stable drops. The drop life depends roughly on the third power of the concn of the stabilizing agent. Polyelectrolytes such as polymethacrylic acid and carboxymethyl cellulose are better stabilizers as acids than as salts, and this behaviour correlates with interfacial visc but not bulk visc.

Simple mechanical models of drop coalescence can explain only some of the results. In general: (1) any factor which disturbs the O/W interface on a mol scale decreases drop stability; (2) many stabilizers are most effective when they are on the verge of precipitation. (Authors' abstract.)

516. Table of solvent pairs. I. Eslami and P. Dubois. *Chim. et Industr.*, 1958, **80**, 706–7.—Extension and amplification of table of Drury (*Industr. Engng Chem.*, 1952, **44**, 2744); solvents increased from 31 to 44 (6 hydrocarbons—C_6H_6, *cyclo*hexane, C_5H_{12}, styrene, toluene, xylene). V. B.

517. Carbon-type composition of viscous fractions of petroleum. Density–refractivity intercept method. S. S. Kurtz, Jr, *et al.* *Analyt. Chem.*, 1958, **30**, 1224–36.—Examination of *ca* 150 hydrocarbons of various types has shown that the usual methods of calculating densities gives results of sufficient accuracy for use in the determination of C type composition. The densities for all the basic structures with 15, 20, 26, 30, and 40 C atoms have been calculated. A graph is presented which enables the density of any hydrocarbon to be reduced to the corresponding value for a cpd of the same type with 30 C atoms, so that only one density chart is needed. A correlation is presented between the calculated density and refractivity intercept by which the C type composition can be obtained for oils with between 15 and 40 C atoms if the number of C atoms is also known. The latter may be derived from an equation based on mol. wt. and visc–gravity constant. This method is particularly useful for the study of aromatic fractions. Comparison of the present method with other accepted methods applied to 369 oils shows good agreement. It is rapid and of wide application. G. B.

518. Physical and chemical properties of petroleum waxes. W. M. Mazee. *J. Inst. Petrol.*, 1958, **44** (419), 401–5.—Composition of paraffin and microcrystalline waxes and its influence on the physical and chemical properties of these waxes are discussed. Formation of adducts between *n*-alkanes and urea is used to estimate these hydrocarbons, which comprise the major portion of paraffin wax. Paraffin waxes which are susceptible to oxidn can be satisfactorily inhibited by addition of very low concn of phenolic cpds. A. D. S.

519. Thermoplasticity and structural viscosity in bitumen and similar thermoplastics. (In German.) F. Hempel. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (9), 311–16.—An earlier publication (see *Erdöl u. Kohle*, **4**, 1957) by the author is referred to, on regular relationships between dynamic visc and test val by conventional methods conforming to DIN 1955. These connexions are limited first to visc–temp behaviour of numerous bitumen types and similar thermoplastics, based on const shearing stress. By a further investigation series the structural visc phenomenon is investigated fully. From the diagram of flow straight lines at many temp, as a function of velocity gradient against shearing stress, the temp-dependent flow behaviour of a thermoplastic is interpolated or extrapolated according to two different viewpoints: flow behaviour at const shearing stress, and at const velocity gradient. Visc–temp straight lines are obtained by drawing η val in a visc–temp diagram as a function of temp. Two different visc–temp straight lines are obtained—distinguished by degree of slope—from the same structurally viscous materials. This gradient difference—an expression for the structural visc magnitude—introduces the conception of relative thermoplasticity, definable as the quotient of tangent val of the gradients of the two visc–temp straight lines obtained from one structurally viscous material. Numerous charts are presented. R. T.

ANALYSIS AND TESTING

520. Applications of optical microscopy to the control and testing of lubricating greases. B. Bernelin. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1021–39.—After an outline of optical microscopic methods (*cf.* Abs. **1658**, 1954), recent results on greases during manufacture and before, during, and after mechanical and thermal stability tests are given and discussed. W. A. M.

521. A new apparatus for the determination of octane numbers of small samples. D. B. Chitty. *J. Inst. Petrol.*, 1958, **44** (416), 255–6.—Equipment and procedure for determining O.N., under Motor Method conditions, of 60-ml samples of fuels with accuracy. It reduces the fuel held up in carburettor float and saves it during the change-over from reference to test fuel. E. M. I.

522. Capillary-tube viscometry with negligible kinetic energy effects. W. A. Carr and R. G. Wylie. *Nature, Lond.*, 1958, **182**, 1153.—Uncertainties in conventional capillary-tube

viscometry arise from the dependence of the kinetic energy "constant" B on flow rate and on the form of the capillary ends. B is defined by the equation $\nu = Ct - B/t$, where ν is the kinematic visc, t is the time of flow, and C is the principal calibration constant.

B can be reduced to $<2\%$ of its normal value by forming a gradual flare over a few cm of each end of the capillary tube. At flow rates higher than normal the kinetic energy effect could be detected only at flow rates corresponding to Reynolds Nos > three times the highest values encountered in conventional viscometry.

The long flare can be obtained by applying air pressure to a parallel-sided capillary tube with its end sealed whilst it hangs in a temp gradient in a furnace. H. C. E.

523. Capacitance-type B.S. & W. recorder. R. S. Wood. *Oil Gas J.*, 8.12.58, **56** (49), 102.—Basically a pipe-type probe element and an electric circuit, this instrument makes use of the large difference in the dielectric constants for water and crude oil to measure water content. Reliable results are obtained, the whole stream can be continuously and automatically examined. A chart compares line and tank sampling with recorder method. Upper limit of reliability is 50–60% of water. G. A. C.

524. Experiments on analysis of the acid function. E. A. M. F. Dahmen. *Chim. anal.*, 1958, **40**, 378–84, 430–4.—Analytical methods discussed, with special reference to selection and use of solvents for non-aq titrations; such solvents both permit determination of acid and distinguishing between various acid groups in a mixture, in a manner impossible with aq titration. As an example of distinguishing homologues within a group analysis of carboxylic acids by chemical methods, azeotropic dist, mass spectrometry, and gas–liq chromatography are described. (Author's summary.)

525. Determination of trace quantities of hydrocarbons in the atmosphere. E. R. Quiram and W. F. Biller. *Analyt. Chem.*, 1958, **30**, 1166–71.—A sample of air containing 20–200 mg of hydrocarbon is passed through a trap immersed in liq nitrogen. If a large sample is needed, it is drawn through the trap directly from the atmosphere at 1 l/minute. For smaller samples the trap is repeatedly evacuated and refilled from a gas pipette. This operation is followed by means of the pressure gauges connected to a vacuum manifold. This manifold carries six cocks and is connected to two gauges, with ranges of 0–760 mm and 0–1000 μ Hg, and a pump capable of maintaining a vacuum of better than 15 μ Hg in the system. With the aid of the manifold, the contents of the trap are transferred under vacuum to a thimble and thence successively to two absorption tubes, one containing ascarite and dehydrite and the other P_2O_5, and back to the thimble by moving the liq nitrogen bath. Finally, the thimble is removed and its contents transferred to a mass spectrometer where the pressure is measured and the spectrum recorded. If the mixture is simple it can be analysed from the spectrum. Otherwise the total hydrocarbon is determined by subtracting the partial pressure of H_2O and CO_2 from the total. Methane is not determined. Nitrous oxide causes an error. Analysis of a mixture of nine components gave results within 1 p.p.m. The standard deviation between ten labs was 5·7 p.p.m. G. B.

526. Polarographic estimation of thiophenes and aromatic sulphides in petroleum. H. V. Drushel and J. F. Miller. *Analyt. Chem.*, 1958, **30**, 1271–80.—Condensed thiophenes and aromatic sulphides in mol dist of chromatographic fractions from crude oils and in straight-run kerosine and fuel oil dist are oxidized to the sulphones with H_2O_2 and then reduced at the dropping mercury electrode. The oxidn is achieved by refluxing a soln of the sample in benzene for 2 hr with H_2O_2 in acetic acid. The mol ratio of H_2O_2 to total sulphur should be 3 : 1. The reduction is carried out in a soln of tetra-*n*-butylammonium iodide in methanol, to which the sulphone is added as a soln in benzene to make a final soln 0·08M in tetra-*n*-butylammonium iodide with a benzene to methanol ratio of 3 : 2 by vol. Polarograms are recorded between −0·6 V and −2·4 V with a mercury pool electrode. The polarographic behaviour of some pure sulphones has been studied. From a comparison of the polarograms of samples with those of pure sulphones and consideration of the sulphur cpds which could be present in the cut from which the sample was prepared, it is tentatively concluded that there are only three main classes of sulphur cpd in crude oil, namely, aliphatic sulphides, thiophenes, and diaryl sulphides. The sum of sulphur found as these three types accounted for more than 90% of the total sulphur in the samples examined. 33 refs. G. B.

527. Softening point determination after Kraemer and Sarnow. (In German.) K. Pletke. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (9), 322–3.—Preference for the R. & B. method for soft. pt. determination of bitumen to the K.–S. method is criticized. The following points are presented in support of retaining the K.–S. test in German spec. Use of Hg is proved to be safe. The procedure is quicker and the results equal in accuracy those of the R. & B. method. Smaller quantities of material are required for the test; this is advantageous and often decisive. Tech improvements are possible to perfect the process. Use of an elec hot plate is preferable to the gas flame used in the R. & B. method. The K.–S. has an automatic control lamp indicator, operating shortly before the soft. pt. is obtained. Another advantage is the simultaneous performance of several tests. The K.–S. method must remain in the standards, also the method is conventional for pitches. R. T.

528. Low pressure electric discharge detectors. R. C. Pitkethly. *Analyt. Chem.*, 1958, **30**, 1309–14.—A sensitive detector for use in the gas–liq chromatography of hydrocarbons can be made in the lab by fitting inlet and outlet tubes and an internal baffle to a neon lamp. Two detectors, one for the pure carrier gas and one for the carrier and sample, are connected in a balanced bridge. They are excited with 400 V d.c. and the voltage drop between the electrodes is measured. The current is limited by a series resistor to 1·5 mA. The limit of detection of paraffins is 10^{-11} mol at a concn of $1 : 10^7$ in nitrogen. The design of the tubes, with suggestions for further development, is discussed. G. B.

529. Colorimetric determination of phosphorus in gasolines containing tritolyl phosphate. F. F. Hoffman *et al.* *Analyt. Chem.*, 1958, **30**, 1334–6.—The method described is rapid and sufficiently accurate for the control of blending. *Ca* 2 ml of the sample, containing 20–50 μg of P, is evaporated almost to dryness in a flask in a steam bath with the help of an air jet directed across the surface. The residue is oxidized by heating with H_2SO_4 and H_2O_2. The soln is diluted with H_2O (25 ml) and neutralized to phenolphthalein with aq NaOH. Then 5 ml of 5·5N H_2SO_4, 2 ml of 2·5% ammonium molybdate soln, and 2 ml of 0·5% hydrazine sulphate are added in that order. The soln is heated in a water bath for 10 minutes, cooled, and diluted to 50 ml with H_2O. The absorbence is measured at 825 mμ. The standard deviation both for repeatability (20 degrees of freedom) and for reproducibility (9 degrees of freedom) is 0·9 mg P/gal. One analyst can complete 15 determinations in 8 hr. A single determination takes 90 minutes. G. B.

530. Vehicle dynamometers. An automotive chassis dynamometer installation for fuel and lubricating oil research. H. J. Eatwell. *Auto. Engr*, 1958, **48** (8), 297–302.—Description of the dynamometer installed at Sunbury Research Station, giving mechanical details of the design and instru-

mentation. It is designed to test vehicles from 28 b.h.p. to those of 300 b.h.p. with fully-laden weights under simulated road conditions. It is particularly useful in speeding up and improving the accuracy of tests for octane requirement, anti-knock rating, vapour tolerance of vehicles, vapour locking tendencies of gasolines, and overall performance of vehicles with different fuels and lubricants. E. M. I.

531. Determination of traces of water in hydrocarbons in gasoline boiling range. Sample handling and interferences. J. W. Loveland *et al.* *Analyt. Chem.*, 1958, **30**, 1316–21.—A technique is described by which samples can be collected and titrated with Karl Fischer reagent without exposure to the atmosphere. In the plant a sampling line is provided, the end of which passes through a two-holed bung. A bottle is fitted on the bung and the exit hole closed. For sampling, this bottle is replaced by a sample bottle dried for 8 hr at 150° F. The filled sample bottle is closed with a neoprene cap similarly dried. The sample is transferred to the titration flask by means of a syringe. The titration apparatus comprises a five-necked flask fitted with a reservoir burette, a magnetic stirrer, inlets for the sample and solvent, a suction tube for emptying, and electrodes for the indication of the end point. All vents are guarded by dessicant tubes. If the sample contains more than 10 p.p.m. of mercaptans, a second titration is made on a sample dried by percolation through $CaSO_4$ and the water determined by difference. For samples from the same source, a constant correction can be made for mercaptans. G. B.

532. Gas liquid partition chromatography of mixtures of methylene*cyclo*hexane and the isomeric methyl*cyclo*hexenes. E. Gil-Av, J. Herling, and J. Shabtai. *J. Chromatog.*, 1958, **1**, 508–12.—The boiling points of these cpds are too close to permit analysis of mixtures by fractional dist. I.r. absorption spectroscopy permits complete analysis but is less rapid than G.L.P.C. Complete separation can be achieved on a 2-m column with glycol saturated with $AgNO_3$ as the stationary phase supported on diatomaceous earth fire brick ground to 50–80 mesh. Helium is used as the carrier gas at an inlet pressure of 17 p.s.i. and flow rate of 66 ml/minute. The column temp is 30°. Ethyl benzene is used as internal standard and the sample size is approx 0·005 ml. Retention vol relative to ethyl benzene are: 1-methyl*cyclo*hexene, 0·42; 3-methyl*cyclo*hexene, 1·65; 4-methyl*cyclo*hexene, 1·59; methylene*cyclo*hexane, 2·99. Concn of the components are determined from the areas under the peaks. The results of the analysis of five mixtures show a mean deviation from the known concn of 0·6% of the total and a max deviation of 1·2%, which is better than that obtained by i.r. absorption. G. B.

533. Effect of the carrier gas on the sensitivity of a thermal conductivity detector in gas chromatography. N. H. Ray. *Nature, Lond.*, 1958, **182**, 1663.—It is shown mathematically that the sensitivity of the detector is proportionate to $(K_1-K_2)/K_1^2$, where K_1 and K_2 are the thermal conductivities of carrier gas and organic vapour. Thus, the carrier gas of lowest K_1 will give the highest sensitivity, and this is confirmed experimentally by comparing the peak heights produced by methane, ethane, and propane in helium and argon.

Of the commoner gases, CO_2, N_2O, and A (K_1 = 1·37, 1·44, and 1·58 × 10^3 erg/cm/sec/° C respectively) are likely to give the best results with thermal conductivity detectors. H. C. E.

534. Standardization of mass spectra by means of total ion intensity. A. Hood. *Analyt. Chem.*, 1958, **30**, 1218–20.—In the mass spectrographic analysis of heavy petroleum oils, neither the pressure of the vaporized sample nor the liquid vol can be measured with sufficient accuracy. By the proposed method peak heights are reduced to standard conditions which are independent of sample size and instrument sensitivity. The reduced spectra are then directly comparable. The individual peak heights are multiplied by $\Sigma I_{std}/\Sigma I_{obs}$, where ΣI_{std} depends on the structure and composition of the material and can be calculated for pure cpds or obtained for petroleum fractions from a graph which is given, while ΣI_{obs} is obtained by summation of the peak heights. A plot of the reduced peak heights against mol. wt. gives a smoother curve than that obtained from the parent peak heights. G. B.

535. Aromatic types in heavily cracked gas oil fraction. Combined use of ultra-violet and mass spectrometry. R. J. Gordon, R. J. Moore, and C. E. Muller. *Analyt. Chem.*, 1958, **30**, 1221–4.—A cracked gas oil was examined as a possible source of calibration cpds representative of aromatic cpds in petroleum. The cracked oil was dist and a cut 209°–213° C taken for study. This cut had a sp. gr. of 1·0489, visc of 173·2 S.S.U. at 100° F and 39·1 S.S.U. at 210° F, and V.I. −193. This cut was then separated by chromatography on silica gel into ten fractions. The oil fractions and the solids pptd from them were examined in a spectrophotometer and in a mass spectrometer with a high temp inlet system. The u.v. spectra were run from 1900 to 4000 Å with *iso*-octane as solvent. Those solids which were sparingly soluble were run in benzene from 2700 to 4000 Å. The mass spectra were run from mass number 75 upwards at electrode voltages of 8 V and 70 V. Xylene was used as solvent for the solids. By consideration of the method of preparation and of the three spectra it was concluded that the cut was a mixture of tri- and tetra-nuclear aromatics with fairly simple substituents. Peaks which appear in the 70-V mass spectrum but not in the 8-V were interpreted as due to fragments. It is concluded that such cuts of heavily cracked oils can be useful as secondary calibration materials in the analysis of high mol. wt. petroleum fractions. G. B.

536. Elementary analysis by fluorescent X-ray spectrography. C. Raimbault and G. Baron. *Rev. Inst. franç. Pétrole*, 1958, **13** (9), 1253–64.—The principles underlying fluorescent X-ray spectrography are described, together with the layout of the apparatus for using this technique. It has only been practicable to employ the method in recent years through the development of sufficiently sensitive detectors and strong means of excitation. Even now it is not possible to work with the first 19 elements.

The analyses reveal the elements, and not how they are combined. Qualitative work is rapid. The analyses are not destructive. A large surface is irradiated, so that the results are good for the sample as a whole. The method has a wide range of sensitivity, and can readily distinguish between some elements which are difficult to differentiate by other means. G. D. H.

GAS

537. The expansion of U.S. natural gas. Anon. *Petrol. Press Serv.*, 1958, **25**, 162–7.—Marketed an average annual growth from 1920 of more than 7%. Since 1946 a growth of 9% has been achieved, to reach 10·6 trillion ft³ in 1957, equiv to 4·8 million b.d. oil. Average annual growth of U.S. domestic oil has been 5·5%, reaching 8·8 million b.d. in 1957. Since 1945 *ca* 235,000 miles of gas pipelines have been built, bringing the total to 546,000 miles at 1957 end. Long-distance transmission lines increased by *ca* 80,000–160,000 miles and enabled more gas to be brought from the SW. and Mid-Continent producing regions to Mid-West and NE. areas. Recent developments are the import of gas from Mexico, and import from and export to Canada. So far the U.S.A. has not been affected visibly by the beginning in mid-1954 of Federal control over well-head prices of all gas destined to cross state boundaries (see *Petrol. Press Serv.*, 1958, **25**, 72), few requests

from natural gas producers to increase charges on gas sales to interstate pipeline companies having been granted. However, 1957's generally poor discovery rate for gas—other than in Louisiana—may be due to disincentive effects of price control and to decline in the search for oil (see *Petrol. Press Serv.*, 1958, **25**, 128). Well-head gas prices suffer as a result of greater transport costs to large urban markets, but prices to the user compare favourably with other fuel prices. Growth of natural gas in the U.S.A. will probably slow down, but gas/oil ratios in new fields will tend to increase. R. T.

538. Natural gas in Pakistan. V. S. Swaminathan. *Engineer, Lond.*, 1958, **206**, 839–42.—Natural gas discovered at Sui in W. Pakistan is now being fed (30 m ft³/day) to industrial consumers in Karachi through a 16-inch o.d. 348-mile pipeline. Gas at an initial pressure of 1800 p.s.i.g. is scrubbed free of H_2S and CO_2 by mono-ethanolamine before admitting it to the line at *ca* 1100 p.s.i.g. Eventual demand is anticipated to be 120 m ft³/day. Another 16-inch 217-mile line also feeds Sui gas in the opposite direction to Multan, and will possibly be extended a further 200 miles to Lahore. Gas has a cal. val. of 975 B.t.u/ft³, and in 1956 saved Pakistan importing 160,000 tons of furnace oil. First gas well in E. Pakistan at Sylhet was brought in at the middle of 1957 at the rate of 15 m ft³/day. This gas needs no purification, and a high pressure 8-inch (1200 p.s.i.g.) pipeline 145 miles long to Dacca would feed a variety of industries in the Dacca region at 20 m ft³/day for 40 years. A. C.

ENGINE FUELS

539. A note on colour formation with para-phenylene diamine inhibitors. G. E. Mapstone and A. Hay. *J. Inst. Petrol.*, 1958, **44** (416), 257–8.—It is suggested that a condensation reaction takes place when diamine benzene inhibitors with a free para position are used as oxidn inhibitors in gasoline. The product imparts a blue colour and is indophenol. E. M. I.

540. Fuel consumption measurement. Anon. *Auto. Engr*, 1958, **48** (8), 312–13.—This describes a precision electronic apparatus for recording accurately in the lab or engine test house small vol of opaque or coloured liq fuels. It consists basically of a burette, engine-revolution counter, and a time interval meter. A circuit diagram is included. E. M. I.

GAS OIL AND FUEL OIL

541. Fuel for the world's ships. Anon. *Petrol. Press Serv.*, 1958, **25**, 173–5.—With a turnover ~65 million tons a year (excluding naval requirements) bunker oil service accounts for $>\frac{1}{10}$ of the free world's total oil consumption, and *ca* $\frac{1}{8}$ of its black oil consumption alone. There are over 250 ports at which ocean-going ships can obtain bunker oils. The service is provided by the international oil companies and involves considerable capital investment. Many ports are near refineries, others are kept supplied by refineries farther afield. The bunker trade is keenly competitive and is conducted on an annual contract basis. Prices vary with current market conditions, the main indices being the posted prices in the U.S. Gulf/Caribbean and Middle East markets and the level of tanker freight charges. Since 1945 end marine fuel oil has risen by $\frac{3}{4}$, from *ca* 100*s.* to 167*s.* 6*d.*/ton at W. European ports, that of marine diesel oil has approx doubled from 120*s.* to 235*s.*/ton. The difference reflects the disproportionate increase in demand for dist fuels for heating purposes and for automotive, railway, and other uses. Roughly 30% of total free world bunker oil deliveries were effected in the U.S.A., which depends largely on coastwise shipping. Growth of bunker oil sales is due chiefly to world trade expansion, change-over from coal-to-oil-firing, and increased speeds. A motor vessel shows a substantial saving in fuel costs to set against higher capital and maintenance charges. This is greater if the motor vessel consumes fuel oil in its diesel engines. Recession in the shipping industry has retarded growth of bunker oil sales. Progress will follow the end of the recession, but at a slower rate; the change-over from coal- to oil-firing has long passed its peak. R. T.

542. The selection and use of additives in oil fired boilers. W. D. Jarvis. *J. Inst. Fuel*, 1958, **31** (214), 480.—An account is given of experiences with various additives to alleviate troubles encountered in power station boilers when oil fired. In the case of superheater deposits formed from oil ash, trials have shown that these deposits can be modified by such additives as dolomite and magnesium oxide. A friable deposit was produced which could be removed more easily from heating surfaces by off-load cleaning methods. When superheater blockage was accompanied by slag formation in the combustion chamber, the additives did not appear to give significant reduction of oil-heater corrosion, but the corrosion of ducting and I.D. fans was reduced. When ammonia gas was used as additive, the acid development was suppressed, but deposition of acid ammonium sulphate on air heater surfaces caused rapid blockage of gas passages; corrosion of metal continued at reduced rate. Among other additives discussed were the liq coal tar derivatives. Suggestions are made concerning possible use of unburnt gases to reduce sulphur trioxide content of flue gases. A discussion and an appendix on testing techniques are included. 36 refs. D. K.

LUBRICANTS

543. Oil-whip resonance. E. H. Hull. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (7), 1490–6.—A series of oil-whip resonance harmonics is demonstrated by applying a rotating force to a shaft running in a hydrodynamically lubricated bearing. Resonances occur at several ratios of the shaft speed to the exciting-force frequency, both when the sense of rotation is the same and opposite. The locus of the shaft centre at these resonances traces a trochoid containing a number of loops equal to one-half the number of shaft revolutions. The peak displacement at resonance is dependent on the test bearing oil supply pressure. 5 refs. E. M. I.

544. Solution of Reynolds' equation for finite journal bearings. O. Pinkus. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (4), 858–64.—The solution of Reynolds' equation has been extended to 100° and 75° arcs, and the results applied to full three-groove and four-groove journal bearings. Using results previously calculated, a full set of solutions is given from 360° down to 75° arcs, including eccentricity ratio, attitude angle, flow coeff, and power-loss factor as functions of the Sommerfeld number. These solutions are based on a load vector acting symmetrically with respect to the bearing boundaries. 8 refs. E. M. I.

545. The behaviour of the lubricating film and side leakage in dynamically loaded bearings. M. Z. Ozdas. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (4), 826–32.—This describes, with 15 photographs, the behaviour of the lubricating film of bearings under static or sinusoidally varying load. Cavitation occurred in both cases, except when lightly loaded. Under sinusoidal load used in the tests (up to 500/minute max load alteration) the film formed and reformed at each load region of the bearing, the load-supporting film moving intermittently within the clearance space in the direction of shaft rotation at a speed equal to the alteration of the load cycle. End leakage was studied and was found to depend on the ratio of the load alterations/minute to the shaft rotational speed. 10 refs. E. M. I.

546. Analysis and residual stress in ground surfaces of high-temperature alloys. R. D. Halverstadt. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (4), 929–40.—In this analysis one of the factors investigated was the effect of the grinding fluid on residual stress. Three fluids—a chemical emulsion with water 20 : 1, a soluble oil with water 20 : 1, and a sulphurated oil—were tested with three alloys under different conditions of grinding. Sulphurated oil is shown to be superior at low wheel speeds. 6 refs. E. M. I.

547. Purification of vegetable oils usable for edible purposes or as engine lubricants. M. Bourjol and M. Ortigues. *Chim. et Industr.*, 1958, **80**, 712–15.—Brief notes on regeneration of castor oil: filtration; neutralization (distilling acids off with steam, use of alkali (NH_3, NaOH, $Ca(OH)_2$)); bleaching (earth); diluent removal (air-free steam, with or without superheat). Used oils containing suspended C, gasoline, and acidity up to 10% (as oleic) can be restored to original spec except as regards colour, always slightly darker for recovered oil. V. B.

548. Influence of pressure and temperature on oil viscosity in thrust bearings. B. Sternlicht. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (5), 1108–12.—The influence that pressure and temp play on oil visc and, in turn, on bearing performance, can be theoretically determined by solving the energy and Reynolds' equations simultaneously. Suggested that effect of pressure on visc may explain why different oils perform in different ways in heavily loaded machine elements, such as gears. A. D. S.

549. Viscosity–pressure effect on friction and temperature in a journal bearing. S. J. Needs. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (5), 1099–103.—Importance of increase in visc of lubricants with pressure on machine elements is investigated. Results show that increased visc of oil with film pressure causes a relatively large increase in friction in heavily loaded bearings. Oil-film thickness also increases with increase in oil visc and may account for fact that heavily loaded bearings operate under hydrodynamic conditions. A. D. S.

550. The acceleration of pitting failure by water in the lubricant. L. Grunberg and D. Scott. *J. Inst. Petrol.*, 1958, **44** (419), 406–10.—Four-ball rolling test is used to study effect of water content of the lubricant on incidence of pitting type failure of ball bearings. Tests carried out on several oils with widely varying water contents showed that presence of water accelerated pitting failure of conventional EN. 31 steel balls but had no effect on stainless steel balls. Microscopic investigations of the initiation of damage to balls under different lubricant conditions are described. On the basis of results obtained it is concluded that strict precautions should be taken to prevent contamination of lubricants with water. A. D. S.

551. The mechanism of sludge suspension in engine oil. P. J. Agius and D. Mulvey. *J. Inst. Petrol.*, 1958, **44** (416), 229–42.—This paper deals with the measurement of the electrophoretic mobility of engine sludge in oil solutions of additives. The charges conferred by different dispersant additives on the sludge particles, and the sludge dispersancy values individually and with mixtures of additives are given. Only with vinyl ester polymer as one component was the sludge dispersancy value of mixtures of additives of opposing electrophoretic mobility high. This type of additive was found to have a low electrophoretic mobility and high visc compared to the others. Its sludge suspension was very stable and not coagulated by the addition of additives imposing an opposing mobility on the sludge, and the mobility was dependent on temp but not visc. The author discusses the theory of the presence of an electrical double layer at the sludge liq interface but points out that in the case of the polymeric type of additive it plays only a minor role in the stabilization of the sludge. Absorption and saturation are suggested instead. 12 refs. E. M. I.

552. Oil seals to provide positive lubrication on large or high-speed thrust bearings. R. A. Baudry, G. E. Peterson, and G. D. Cooper. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (4), 819–25.—This is a study of the behaviour of the oil-film which separates thrust bearings of the type used in water-wheel generators. The hazards involved with excessive turbulence and aeration, its interference with the formation of the oil-film, causing oil-leaks, and how it is prevented by the use of oil-seals are described. Tests on different seals using a special test model are given. 3 refs. E. M. I.

553. Better deasphalting keys lube-oil modernization. C. S. Cronan. *Chem. Engng*, 1958, **65** (22), 54.—A noteworthy feature of the new deasphalting plant at Shell Oil Co's refinery at Wood River, Illinois, is the first time use of rotating disk contactors at relatively high pressures needed for propane deasphalting. This consists internally of a series of disks (rotors) mounted on a vertical rotating shaft. The rotating disk contactors give better countercurrent mixing of oil and propane and get 5–10% more deasphalted oil than previous mixing and settling method. When modernization is complete in May 1959, *ca* 4000 b.d. of finished lub oil will be produced. Attractive economics in capital and running costs are the main feature of the present modernization. M. F. M.

BITUMEN, ASPHALT, AND TAR

554. Consolidation problem on cavity-poor bituminous tracks. (In German.) H. Lenhard. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (8), 294–6.—Development of road construction technique—discussed with explanatory diagrams—must be adapted to growing road traffic, namely, number of vehicles, axle load, and speed. A reliable ref. pt. may be obtained for compression readiness of the bituminous material to be added, up to the state of equilibrium of cavity-poor track coverings, in relation to the compression work by traffic- and rolling-load. Only thereby can vehicle and track covering be matched in the sense of a tech unit. Solution of the compression problem of cavity-poor track coverings is to be seen in the evidence of the dependence relation on the compression work and the bituminous material to be added. R. T.

555. What chemists have learned about asphalt. J. W. Romberg and R. N. Traxler. *Petrol. Engr*, 1958, **30** (11), C37.—From studies made in recent years it has become evident that a high percentage of molecules in asphalt contain elements other than carbon and hydrogen, and that we are dealing with an extremely complicated aggregation of organic cpds. The theory that highly condensed aromatic cpds probably predominate in asphalts now appears to be unsound. The mol carbon to hydrogen ratios recently reported are not high enough to support this theory.

The many and varied uses for asphalt depend primarily upon its colloidal properties which determine the rheological characteristics of asphalts. The colloidal properties in turn are determined by the chemical composition of asphalt, and as more becomes known of the composition, it should be possible to define a composition required for a particular use.

The paper discusses in detail the types of carbon cpds in asphalts, mol. wt. of different types, occurrence of sulphur, oxygen, nitrogen, metals, and salts, and the important physical, colloidal, and chemical properties. M. F. M.

556. Ideas for tar-concrete construction. (In German.) T. Temme. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (8), 283–6.—Success with bitumen coatings–sand-asphalt, asphalt-fine-, or coarse-concrete—has stimulated the development of tar concrete for road coverings. These coverings are constructed

after the macadam principle, with layers of tar mineral mixtures—in themselves of the same granulation degree—of increasing fineness degree in successive superimposed layers. The advantage is that finer grains of succeeding layers fill the gaps in the lower layers to form a relatively rigid bedding. Officially the coarsest grain of the fine concrete mixture must be ⩾2 mm dia. Therefore it is immaterial whether the coarsest grain is 5 or 8 mm or greater; today 12–15 mm is the max dia used. Exact methods as discussed have been specified for production and valuation of the best possible relatively pore-free mixtures. Systematic investigation—stone type, grain size and form, sp. gr., etc.—is essential to determine the effect of changes in relative quantity or nature of any constituent material. Binder visc and quantity have an important bearing on successful pore-free construction.
R. T.

557. Dense tar concrete in Great Britain—DTS dense tar surfacing. (In German.) W. Lorenz. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (8), 275–82.—Dense tar surfacing, as developed in Great Britain during the second world war for aircraft landing fields, is discussed fully. Good results have encouraged extension of the process in Germany and France as described. R. T.

SPECIAL HYDROCARBON PRODUCTS

558. The Fischer–Tropsch synthesis with iron catalysts: the effect of reaction temperature on product composition. D. Gall and P. J. Kipping. *J. Inst. Petrol.*, 1958, **44** (416), 243–53.—A study has been made of Fischer–Tropsch synthesis over the temp range 200°–300° C; chromatographic methods of analysis were used. With increase in temp, the proportion of saturated hydrocarbons remained unchanged, but the proportions of aromatic and unsaturated hydrocarbons increased and cpds containing oxygen decreased. The mean mol. wt. fell. Examination of C_5–C_8 hydrocarbons by gas–liq partition chromatography showed that increase in temp gave an increase in the number of branch-chain isomers present. An analysis of C_1–C_5 alcohols showed a decrease in primary alcohols and straight-chain isomers, indicating again an increase in branch-chain isomers. E. M. I.

559. Ethylene—petrochemical genie. L. F. Hatch. *Petrol. Refin.*, 1958, **37** (11), 214–24.—Ethylene has grown into one of the most dynamic of all petrochemical starting materials, and in this article the complete story of ethylene, its production, derivatives, and future is presented.

It becomes apparent why ethylene plays a dominant role in the petrochemical industry when one considers that it is readily available in large quantities at a low cost. The future of ethylene is closely related to the five types of cpds which account for nearly 90% of ethylene consumption. They are: (1) ethylene oxide; (2) ethyl alcohol; (3) polyethylene; (4) ethyl chloride and dichloride; (5) ethyl benzene.

Ethylene production rose from 0·8 billion lb in 1946 to 4 billion lb in 1957, and an estimated production for 1965 is 6·5 billion lb. Propane is expected to continue as the main source of ethylene production, followed by ethane and refinery off-gases.

The article includes adequate description and flow sheets for the following processes: manufacture of ethylene oxide by direct oxidn of ethylene (Scientific Design Co. Inc.); polyethylene production by the Ziegler low pressure process; and the vinyl chloride production by thermal process (380°–410° C and charcoal cat) and the caustic process. M. F. M.

560. The effect of metals on transformer oils and some methods of protection against adverse effect. J. C. Wood-Mallock, H. Steiner, and L. G. Wood. *J. Inst. Petrol.*, 1958, **44** (418), 320–32.—Data are presented on the soluble copper contents of 56 samples of used oils from small distribution transformers. A lab investigation of factors affecting the rate of dissolution of copper in transformer oils shows that crude source, refining treatment, and presence of oxidn inhibitors, deactivators, and passivators are important. By carefully selecting combinations of deactivator and oxidn inhibitor, copper solubility can be effectively reduced. A comparison is made of the behaviour of these passivated oils under a number of test conditions with that of inhibited oils. A. D. S.

561. The susceptibility of oils to oxidation inhibitors. J. H. T. Brook. *J. Inst. Petrol.*, 1958, **44** (418), 333–5.—By analysing the decomposition products of di-*tert*-butyl peroxide in oil, a measure of the reactivity of the hydrogen atoms in the oil can be obtained. This reactivity is correlated with the reciprocal of the induction period observed when oils, containing phenolic inhibitors, are oxidized in lab tests. Results demonstrate that a simple mechanism can be postulated for oxidn processes occurring in inhibited oils. A. D. S.

562. The oxygen absorption characteristics of inhibited transformer oils. L. Massey and A. C. M. Wilson. *J. Inst. Petrol.*, 1958, **44** (418), 336–56.—A static oxygen absorption test is used to study oxidn stability of commercial and lab blended inhibited transformer oils. Various conditions of temp, cat, and inhibitor concn are investigated. The results of adding additional inhibitor to artificially aged inhibited oils and the behaviour of mixed inhibitors are examined. An assessment is made of the relative merits of IP 56 and methods evolved in these studies when applied to commercial inhibited oils. A. D. S.

563. Electrical measuring techniques and their application to insulating oils. G. E. Bennett. *J. Inst. Petrol.*, 1958, **44** (418), 356–66.—Importance and significance of following electrical tests used for quality control of insulating oils are outlined—electrical strength, power factor, and resistivity. Apparatus for this application is described, testing techniques considered, and electrical properties of oil discussed. Further applications of electrical measurements to oils are dealt with briefly. A. D. S.

DERIVED CHEMICAL PRODUCTS

564. Petrochemical engineering achievement at Fawley. Anon. *Chem. Proc. Engng*, 1959, **40**, 19–21; *Industr. Chem.*, 1959, **35**, 17–19.—Esso's new £10 million petrochemical plant yields two main products, C_2H_4 and butadiene. C_2H_4, for use in manufacture of polythene and chemicals, is produced by steam cracking depentanized light naphtha. Presence of steam favours production of olefins and diolefins, while short residence time at high temp minimizes polymerization. After quenching and separation from quench oil, products are compressed and caustic washed. The fraction up to C_2 is separated in absorber towers, by-products being C_3H_8, which is fed to a polymerization unit for production of high octane gasoline, C_4's, which go to a butadiene extraction unit, and C_5+, which is clayed and sweetened for gasoline blending. C_2H_2 in the C_2 fraction is selectively hydrogenated, and separation of pure C_2H_4 is effected by low-temp fractional dist. Butadiene, for manufacture of synthetic rubber, is produced by cat dehydrogenation of a C_3/C_4 cat cracker stream, after removal of C_3H_8 and *iso*C_4H_{10} and extraction and dimerization of *iso*C_4H_8. The product, together with the C_4 stream from the steam cracking process, is purified by extraction with cuprous ammonium acetate, the extract is stripped, and the butadiene washed to remove NH_3 and rerun in a fractionating tower, giving 98·5% purity. W. A. M.

565. Some questions concerning the establishment of the petrochemical industry. P. Gustavson. *Kimija u Industriji*, 1958, **7** (12), 319–30. In this article the production of olefins and the possibilities of their manufacture under the

conditions prevailing in Yugoslavia is discussed. The author deals with the production of pure olefins from gas mixtures, the hydrocarbon pyrolysis, the pyrolysis conditions, the amount of raw materials needed, the methods for the hydrocarbon pyrolysis, as well as the economic analysis with reference to the specific conditions in Yugoslavia.

(Author's abstract.)

MISCELLANEOUS PRODUCTS

566. The low temperature liquid phase oxidation of hydrocarbons: a literature survey. F. Morton and R. T. T. Bell. *J. Inst. Petrol.*, 1958, **44** (417), 260–72.—This paper reviews the theories advanced concerning the reaction mechanism of the oxidn of hydrocarbons and relates the knowledge to the behaviour of transformer oils in practice and acceptance tests. Catalysis by soluble metal salts and metal surfaces is dealt with and there is a short section on oxidn inhibitors. 65 refs.

E. M. I.

567. ERA/IEC work on oxidation tests for insulating oils in the last decade. P. W. L. Gossling. *J. Inst. Petrol.*, 1958, **44** (147), 273–83.—This paper summarizes the British work since 1949 in an international programme to obtain one standard method of testing the oxidn of insulating oils. Methods investigated included ASTM D670–42T, ASTM D974–51T, ASTM D664–51, B.S. 148, IP Method 1A and 1B, and the IEC Test. Standard reference oils were tested under different conditions and with different cat. International results are quoted, and a case is set forward for the use of soluble metal cat instead of metallic ones. 13 refs.

E. M. I.

568. A thermocouple method of studying oxidation reactions. Pt I. Photosensitized oxidation of *cyclo*hexane. J. C. Robb and M. Shahin. *J. Inst. Petrol.*, 1958, **44** (417), 283–90.—This describes a thermometric method for studying the non-stationary state of the oxidn reactions of hydrocarbons based on using a single thermocouple junction in conjunction with a low independance d.c. amplifier and recording system. The reaction is photochemically induced and time–temp curves for the reaction can give information of the rate of oxidn. *cyclo*Hexane was studied at 40° C and rate constants for the propagation and termination reactions are given and compared with previous work. The retardation effect using 2,6-di-*t*-butyl-*p*-cresol was studied and its mechanism discussed. 9 refs.

E. M. I.

569. Kinetics of low temperature metal-catalysed hydrocarbon oxidation. C. E. H. Bawn and D. P. Moran. *J. Inst. Petrol.*, 1958, **44** (417), 290–5.—This paper discusses the mechanism of the cat action of small amounts of metals in autoxidation reactions relating them to the sludge formation and acidity of transformer oils. Results are given for a study of the oxidn of ethylbenzene at 80° C using copper stearate as cat. It was found that the reaction conformed to the radical chain mechanism, forming a hydroperoxide which complexes with the metal salt, but the complete description of the mechanism is only suggested as the work has yet to be completed. 9 refs.

E. M. I.

570. Mechanism of copper catalysis in insulating oil oxidation. C. N. Thompson. *J. Inst. Petrol.*, 1958, **44** (417), 295–310.—This paper describes a series of tests which prove that the reaction mechanism of copper cat in the oxidn of insulating oils is homogeneous and not heterogeneous. The experiments were all based on the IEC Oxidation Test and a variety of cat conditions was employed. Evidence from the studies also showed that the so-called variable corrosivity effect can be ignored. A correlation was found to exist between the results of tests with metallic and soluble cat, proving the reaction to be homogeneous and suggesting that soluble salts can safely be used in rating the oxidn characteristics of insulating oils. 14 refs.

E. M. I.

CORROSION

571. Electrochemical corrosion tests and their application to stainless steels. J. M. Defranoux. *Rev. Inst. franç. Pétrole*, 1958, **13**, 866–74.—Electrochem corrosion tests are superior to conventional corrosion tests, since it is possible to study separately each of several factors involved. Basis of electrochem method is outlined, and construction of simple and coupled polarization curves and potential/time curves described and illustrated. Method is applied to corrosion of stainless steel by NaCl soln under given conditions.

W. A. M.

572. Design factors in corrosion control. R. V. Jelinek. *Chem. Engng*, 1958, **65** (23), 151–5.—By observing six simple rules based on corrosion principles and sound engineering practice it is possible to avoid most engineering mistakes. The rules are: (1) avoid galvanic couples; (2) avoid opportunities for concentration cells; (3) avoid localized stresses; (4) keep surfaces smooth and streamlined; (5) keep surface-to-vol ratio low; and (6) specify strict fabrication standards and provide frequent inspection.

The above six factors are discussed in the paper with the aid of useful illustrations and diagrams.

M. F. M.

573. Some applications of high nickel alloys in the petroleum industry. Pt II. G. L. Swales. *Petroleum, Lond.*, 1958, **21** (12), 439.—This part of the article deals with applications of high nickel alloys to combat specific corrosion problems in a variety of refinery treating processes. It also discusses a selection of materials for high temp applications in refinery and associated petrochemical processes. Particular attention has been paid to corrosion problems involved in hydrofluoric acid alkylation, sulphuric acid alkylation, amine gas treatment, caustic treatment, furfural treatment of lub oils, and the selection of materials for high temp furnace tubes and flare stack tips.

M. F. M.

574. API survey shows few amine corrosion problems. Anon. *Petrol. Refin.*, 1958, **37** (11), 281.—The API Sub-Committee on Corrosion recently appointed a panel to study "Corrosion in Alkaline Hydrogen Sulphide and Mercaptan Stripping Systems." This panel collected data on 36 aq amine units and one glycol–amine type unit. The functions of the stripping systems varied widely and included feed gas treatment, sulphur recovery, ammonia synthesis, cat polymerization, and fuel gas treatment. Steam was used as the reactivator reboiler heating medium at temp varying from 235° to 450° F. Pressures used varied from atmospheric to 85 p.s.i.g.

The survey reveals that only nine out of the 37 cases had any existing corrosion problem and four of those cases have not restored to selection of alloy materials. The only definite corrosion problem is on the reboiler tubes and, to a smaller extent, on acid gas cooler. The general consensus of opinion on proper alloy selection to prevent this attack seems to be type 304 stainless steel. A probable correlation between high CO_2 content in the acid gas and corrosion in the acid gas cooler was noted. This was based on carbon steel performance.

The article includes the survey data in full and also a comprehensive literature survey.

M. F. M.

575. How Interstate uses deep ground beds to protect bare pipelines. R. L. Bullock. *Oil Gas J.*, 8.12.58, **56** (49), 94.—A new type deep ground bed employing graphite rods and coke breeze backfill has been successfully field tested by Interstate Oil Pipe Line Co. on their Central and SW. Mississippi lines, where severe corrosion makes cathodic protection necessary, using high-current output rectifiers. It is essential that the hole must be straight and clean of all cuttings, and of at least 2 inches dia. Charts give installation and cost data.

G. A. C.

ENGINES AND AUTOMOTIVE EQUIPMENT

576. Series—parallel centrifugal compressor brings flexibility. R. E. Schuhmann. *Petrol. Engr*, 1958, **30** (12), D19.—A new centrifugal compressor that is basically two compressors in one case is claimed to have unprecedented flexibility and high efficiency and to be able to cope with widely varying operating throughputs. It has four impellers mounted on a single shaft with two suction and two discharge connexions on oppsite sides of the case. It can be operated as either two parallel compressors or two compressors in series with gas piped through all four wheels.

The compressor's normal discharge pressure is 900–1000 p.s.i.g. The capacity in series, at best efficiency point 208 MMSCFD and in parallel, at best efficiency point 600 MMSCFD. C.R. range from 1·12 to 1·67. Installed cost of a station comprising this type of unit is the same as any other type of compressor performing the same function.

A detailed physical description of the unit is given in the paper, together with graphs indicating such data as the polytropic efficiency at different compressor rev/min, flow *v.* C.R. curves, and total head *v.* capacity curves. M. F. M.

SAFETY PRECAUTIONS

577. Antistatic additives in the petroleum industry. A. Klinkenberg and B. V. Poulston. *J. Inst. Petrol.*, 1958, **44** (419), 379–89.—Operations, including pumping of petroleum products through pipelines at high speed, can result in accumulation of electrostatic charges, sufficient to cause explosions. This can be satisfactorily prevented by increasing the electrical conductivity of the product and can be achieved by means of very low concn of an antistatic additive. The stability of such an additive during handling, type of products to be protected, and effect of the additive on specification properties of the products are discussed.

A. D. S.

ECONOMICS AND MARKETING

578. U.S.S.R. competes in world oil market. E. Adams. *Petrol. Engr*, 1958, **30** (11), E34.—The Middle East and Venezuela, largest oil exporters, find a new competitor. A recent issue of the official organ of the U.S.S.R. Ministry of Foreign Trade claims that the Soviet Union has now replaced American and Anglo-Dutch monopolies in selling liq fuels to many countries in Africa, Asia, and Latin America.

Russian oil exports passed the 10 million metric ton mark for the first time in 1956, this figure being almost twice as high as the highest level of Russian export of oil and oil products before world war II. Of the total amount of Russian exports to non-Communist countries *ca* 35% went to Africa, Asia, and Latin America, 20% to Finland, and 35% to W. Europe. China is the largest single buyer of Russian oil products.

M. F. M.

MISCELLANEOUS

579. Wrought steels for the petroleum industry. S. Barraclough. *Inst. Petrol. Rev.*, 1958, **12** (143), 370–4.—A general survey of carbon, low alloy, and high alloy steels suitable for use in the petroleum industry. The composition and mechanical properties of these different steels are given and discussed.

E. M. I.

580. How do you get the viscosity of a gas mixture? W. R. Gambill. *Chem. Engng*, 1958, **65** (23), 157–60.—At a given temp and pressure, the visc of a mixture of gas can vary with composition in a highly irregular manner. For many binary mixtures the visc curve may pass through a max which may be greater than either component. In this article various estimation methods with which mixture visc may be calculated from known pure component data are discussed. Separate treatment is given to estimation methods for low-pressure and high-pressure conditions. Charts (Bromley–Wilke) are provided from which visc of mixtures for both low mol. wt. and high mol. wt. ratios can be deduced. An overall summary of the best estimation methods for gas mixture visc is also included, which should prove most useful to those interested.

M. F. M.

581. Applied hydrocarbon thermodynamics. Pt 9. W. C. Edmister. *Petrol. Refin.*, 1958, **37** (10), 111–23.—The exponents that define the temp and vol changes for reversible adiabatic, and polytropic compression and expansion of gases are derived from heat capacity and compressibility factor relationships. Such data can be used with entropy balances in the development of more simple and convenient exponent correlations which are presented in the paper.

Plots of K *v.* temp for hydrocarbons and other gases are given and entropy balance equations are derived for isentropic compression and expansion of gases. Calculation of isentropic exponents is described in detail and the paper contains comprehensive data on isentropic exponent differences for different values of k (from 1·025 to 1·30). M. F. M.

582. Plastic metals minimize plant shutdowns. R. B. Norden. *Chem. Engng*, 1958, **65** (22), 150.—There are a number of techniques available for repair of large and small chemical equipment, requiring a minimum of shutdown period. A method gaining rapid attention is the use of plastic metals. These are putty cpds which harden after they are applied. Their technique of application is very simple and no heat is necessary. The plastic-metal putty contains *ca* 80% powdered metal and 20% plastic. A curing agent is added to putty just before application. A new putty containing 94% lead has just been introduced to the market by Devon Corpn, Mass., which is very suitable for repair of lead and lead-lined tanks.

Metal putties, particularly steel and aluminium, have, on the whole, excellent resistance to most solvents and stand up fairly well to HCl (100% and 50%) and H_2SO_4 (50%), but fail against 100% H_2SO_4. M. F. M.

583. Electronic data processing and management in the chemical and petroleum industry. J. W. Reading. *Industr. Engng Chem.*, 1958, **50** (11), 1622.—Electronic data processing systems for handling business data have been in use for more than six years. Though the electronic "brains" cannot substitute for management in making decisions, they provide a firm and precise background on which management can base intuitive solutions to complex operation problems. The machine is an efficient link in information flow, and the electronic data processing will strengthen management's control by providing means for more systematic evaluation of complex operating problems. M. F. M.

584. Analogue computing in the chemical and petroleum industries, past and present. T. J. Williams. *Industr. Engng Chem.*, 1958, **50** (11), 1631.—The electronic differential analyser type of analogue computer is now commonly used. Having been a vital tool of the defence industries almost from its conception in the late 1940's, it is now becoming an equally important tool of the chemist and chemical engineer.

This report traces some of the background and the history and application of these machines, especially as related to the chemical and petroleum industries. The present applicability of analogues is defined in relation to other available means of computation, and the areas where their use holds the most promise are specified.

The analogue computer has definite limitations as a general purpose computer, and its procurement by a particular company should be justified only on the basis of contemplated workload in the fields of automatic process control and chemical process transients. M. F. M.

585. Worldwide oil report. P. Swain and R. Gibson. *Oil Gas J.*, 29.12.58, **56** (52), 87.—The annual survey is given of the world's reserves, wells, production, and refining capacities, country by country, but excluding the U.S.A. and Canada. Maps and statistical tables are shown and a review of activities in each area. G. A. C.

586. The French oil law for the Saharan regions. Anon. *Petrol. Times*, 19.12.58, **62** (1601), 1009.—Some details of the new law of 22 Nov. 1958, are outlined. A novelty of the new law is that a concession holder is party to a bilateral agreement, detailed and annexed to the grant of concession.

Two types of exploration permit are provided; the first permits exploration (except drilling) within a defined area, the second an exploration permit properly speaking (the H permit), giving exclusive rights against other holders of this type of permit and precedence over the holders within the area it comprises of the first type of permit.

Exploitation articles define the different aspects or phases of exploitation work in relation to the French Codes of Law. One point is that during the validity of an H permit only the holder can obtain a concession within the area. A concession is for a period of 50 years, and may be granted only to an applicant with the necessary technical and financial capacity. Regarding transportation, authorization gives the holder the absolute right to transport the product within the O.C.R.S. zones.

Fiscal provisions have in essence the exemption of holders of concessions from all direct taxation of the usual kind in order to subject them directly to a liability to a royalty of 12½% (5% for gas) and to a further tax equal to 50% of net profits.

Transitory provisions relate to transfer to the territory of the franc area of dividends and other assets. G. A. C.

587. Testing-time in Turkey. Anon. *Petrol. Press Serv.*, 1958, **25**, 213–15.—Kerosine demand in Turkey is rising for domestic use. Fuel oil consumption is relatively low, and little is imported. Local demand is satisfied mainly from local crude. Apart from the rapid rise in population, demand for petroleum products would be higher but for restrictions or heavy duties on imports of other goods and oil-consuming equipment. ⅘ of Turkey's total oil needs, but a higher proportion of gasoline and gas/diesel oil, and all kerosine supplies are imported as finished products. In two or three years time practically all imports will be displaced by products from the projected new refinery—capacity 3,250,000 tons—plus 300,000 tons from the Batman refinery. The reasonable petroleum legislation enacted in 1954 and amended in 1955 and 1957 has encouraged oil exploration. Some 15–20 firms, mostly foreign, have been granted over 200 licences covering altogether *ca* 23 million acres. Up to the present nine foreign concerns are drilling or intend to drill shortly. Gas has been found at Baku, near Karachuk, in the tongue of Syrian territory running up between Turkey and Iraq, where oil was found late in 1956. Natural gas reserves are believed to exist at Murefte on the S. Thracian coast of the Sea of Marmara. Worthwhile discoveries will be a boon to the country by reason of the relief it will bring to Turkey's payment balance. R. T.

588. Eastern Europe's energy supplies. Anon. *Petrol. Press Serv.*, 1958, **25**, 181–4.—Fuel availability—Russian relief now being limited—is the major hindrance to further industrial expansion in Russia's E. European satellite states. E.C.E.'s latest report shows that production has increased more slowly than energy sources in Poland, E. Germany, Czechoslovakia, Hungary, Rumania, and Bulgaria. In Czechoslovakia alone is energy production rising currently more rapidly than consumption. Surplus electricity generating capacity is disappearing. Small nuclear power plants will be completed by 1960 in the states. Poland has been long a coal exporter, notably to the U.S.S.R. and her satellites. E. Germany and Czechoslovakia have to rely on low-grade coal, the latter is co-operating in hard coal mine development in Poland. E.C.E.—with other available information—shows that, thanks to Rumanian oil output, the area's production has more than doubled during the past seven years, reaching 13 million tons in 1957, with a prospect of 18 million tons in 1960. *Ca* 85% of E. Europe's production comes from Rumania—recovering from the 1956 Nagylengel setback—from areas developed in the early 1950's. Production in the other countries is relatively small. Some oil is being produced from lignite in E. Germany and Czechoslovakia. In E. Germany automotive fuels are produced from lignite and imported crude; in Czechoslovakia lignite-based gasoline and diesel oil in the Most hydrogenation plant. The substantial Rumanian oil exports—chiefly to the U.S.S.R.—recently tended to decline, due to domestic demand. Excepting Rumania and Albania, all the satellite countries are net oil importers. Oil imports from the U.S.S.R. have been rising, but taking oil and coal together the U.S.S.R. will remain a net energy importer from the satellites, a net exporter to the rest of the world. R. T.

589. Portugal presses on. Anon. *Petrol. Press Serv.*, 1958, **25**, 261–3.—Oil consumption in Portugal increased from *ca* 770,000 metric tons in 1952 to over 1·1 million tons in 1957. Capacity of the country's only refinery, that of SACOR, is to rise by 300,000 tons to 1·5 million tons p.a.; petrochemical production facilities will be added. Most of the present output is sold in Portugal and Angola. Since May 1955 refinery gases have been sold to the local gasworks for admixture with coal gas. A company has been formed with 60% participation of SACOR to produce gas from oil; also ammonia for

fertilizer production. The tanker fleet of SAPONATA is being increased. Exploration is proceeding in Portugal and in all its African overseas provinces. Production has been established in Angola by a subsidiary of Petrofina. A 100,000-ton topping plant, on stream recently, is to be integrated into a million-ton refinery still under consideration. Portugal's petroleum product consumption is expected to rise at an average rate of 8·5% p.a. A unique feature of the market in Portugal is that the vol of kerosine trade is greater than that in gasoline. R. T.

590. Fuel and power in British industry. F. C. Thompson. *Nature, Lond.*, 1958, **182**, 1713–15.—Report of a symposium held at Manchester, Nov. 1958, and concerned with the interaction between technological advances and their economic consequences.

Following a report by the Minister of Power on the Government's policy, the discussions were devoted to consideration of oil, coal gas, electricity, and nuclear energy.

Two lectures on oil: the economic aspect, and commercial uses, were concerned with the world resources of oil, its distribution, and the substitution of coal by oil. The special uses of oil for particular industrial applications, *e.g.* steel making, were considered.

Other lectures were given on aspects of coal winning and use, manufacture of gas (including the importation of liq gas), heating by electricity, and the economics of nuclear power stations. H. C. E.

BOOK REVIEWS

Chemical Process Economics. John Happel. New York: John Wiley and Sons. London: Chapman and Hall, 1958. Pp. xii + 291, 68*s*.

There has for many years been a need for a book which deals exclusively with the economics of chemical processes, and this book by Professor Happel adequately meets this need. All those economic aspects which should be studied before a new project is launched are discussed in detail in this volume. Capital investment for the necessary facilities, working capital, the effect on gross income of making the proposed investment, the effect of income tax, allowable depreciation for accounting and income tax, minimum attractive return on investment, total profit and cash position, pay-out time—all these most important economic considerations are treated clearly and factually.

The very complicated question of minimum economic size for new plant is dealt with; the concept of "break-even point" for product values *v.* production rates is presented, as it should be, graphically.

The economics of plants and processes which are already in operation are considered separately, and it is pointed out that these considerations may differ from the economics of installing new plant involving new capital investment. The need to review periodically all operations to determine optimum conditions is stressed.

Although the economics are, of course, based on American practice and experience, this detracts little from the value of the book; the general principles are applicable universally.

The book opens with an outline of the principles of the economic balance. This is followed by chapters dealing with expanded economic balance equations and with special mathematical equations, including the application of linear programming methods and statistical methods; the mathematics presented in these chapters are rather complex for the executive, whose maths will probably have become somewhat rusty, but this treatment will be of considerable interest to the student. A most useful chapter giving notes on cost estimation comes next, and this is followed by chapters on risks, return rate, and investment recovery, overall considerations in project analysis, process plant components, and social values in engineering economy. The appendices include practical rules of thumb, cost data, and a summary of formulæ and tables.

Each chapter is completed by a brief but useful summary, and throughout the book excellent examples are worked out in detail to illustrate the principles discussed. Problems for the reader to work out himself are also included, but their value would certainly have been enhanced if the answers had been included—it is always most tantalizing to work out a lengthy problem and, when it is completed, not to know whether the correct answer has been obtained. One must assume that a student working with this type of book is sufficiently adult not to work a problem backwards from the known answer!

This book is a "must" for all students of chemical engineering and should be compulsory reading for all who are about to enter industry. The executive will undoubtedly also benefit considerably by reading it.

The book is excellently bound and produced, and if all the principles discussed are taken into consideration before a new project is implemented, the pay-out time for the capital investment required for the purchase of this book should be a matter of a few minutes. J. L. E.

Axial Flow Compressors. J. H. Horlock. London: Butterworths Scientific Publications, 1958. Pp. xvi + 189, 40*s*.

It is well known that in spite of the considerable theoretical and development work that has been devoted to axial compressors over the last ten years their design is still much more of an art than a science. This may account for the absence hitherto in the U.K. of any book devoted solely to axial flow compressors. This work by Professor J. H. Horlock has filled this gap. It opens with a rigorous treatment of the basic fluid mechanics and thermodynamics necessary for the later chapters. This is followed by a discussion of basic two-dimensional cascade performance. As the subject matter deserves, this is treated most comprehensively, both the American and British approaches and design data being given in some detail. It leads logically to an account of the basic stage design parameters of stagger and degree of reaction. A subsequent chapter deals most adequately with radial equilibrium (departure from standard notation is most noticeable in this section—the well known "constant α_3" blade twist becoming "constant α_2" in Professor Horlock's notation. See E Table 5.1.) The more advanced concepts associated with actuator disk theory are included in this chapter.

Secondary losses, work done factors, off-design performance, and Reynolds number effects are then described. The treatment of these aspects is brief by comparison with some of the earlier chapters—particularly as these are some of the items most discussed by designers—but the treatment is adequate. Secondary flow theory is also outlined very well in this chapter.

The chapter on stalled performance is an excellent and comprehensive survey of present knowledge. This chapter also contains an account of surge phenomena and vibration—the treatment of these items is sketchy but a true reflection of present knowledge. The book concludes with brief chapters on compressor testing and on supersonic compressors.

Professor Horlock has approached the subject from the

fundamental point of view. Some criticism may be made that the book does not deal as fully as might be expected with the more practical aspects of design. For example, the curious results that can be obtained by using British three-dimensional design methods with American cascade data (or vice versa) are not mentioned; the relations of the design to the matching point and its consequences is not discussed; the grading of work amongst the stages and the problem of diffusing stages at the H.P. end of the compressor are only briefly mentioned. Likewise the modern transonic compressor (if the term can be used with any real meaning) is dismissed by a few lines, although the supersonic compressor receives more detailed treatment. However, these are items for which no proper theoretical approach exists. They are only amenable to empirical treatment and are largely subject to contemporary trends in fashion—perhaps most discussed by designers on this account! By concentrating on the more fundamental aspects Professor Horlock has produced a book which will have lasting value. He has developed his theme logically. Where conflicting theories have been unresolved, each is presented in equal detail. The book includes nearly 200 references, so that those who wish to study any particular aspect in greater detail will be aware of the material available.

This book can be most strongly recommended to all who wish to understand the fundamental basis upon which axial compressor design techniques have been built up. It would be invaluable to the research workers, the designer, the development man, and also to the user if he is to get the best out of his machine.

A. D. S. C.

ADDITIONS TO THE LIBRARY

Entries are arranged in subject order according to the Uren " Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the " Library Catalogue " published by the Institute.

050 Molyn, J. H. Dictionary of petroleum: Dutch–English, English–Dutch Hilversum, Oceanic Exchange Co., 1946. 352 p.

060 Kharbanda, Om P. Nomograms for chemical engineers. London, Heywood and Co. Ltd., 1958. 247 p.

080 Gerretson, F. C. History of the Royal Dutch. Leiden, E. J. Brill, 1953. 4 v.

090 British Standards Institution. Methanol. London, BSI, 1958. 13 p. (BS 506 : 1958.)

090 British Standards Institution. Slotted grub screws. London, BSI, 1958. 13 p. (BS 768 : 1958.)

090 British Standards Institution. Steel boiler and superheater tubes. London, BSI, 1958. 40 p. (BS 3059 : 1958.)

090 British Standards Institution. Steel pipe flanges and flanged fittings . . . for the petroleum industry. London, BSI, 1958. 83 p. (BS 1560 : 1958.)

090 American Petroleum Institute. API recommended practice for testing oilwell cements. 7th edition. New York, API, 1958. 34 p. (RP 10B.)

090 American Petroleum Institute. API specification for small welded production tanks. 4th edition. New York, API, 1957. 12 p. (STD 12F.)

090 American Petroleum Institute. Standard for field welding of pipe lines. 5th edition. New York, API, 1958. 26 p. (STD 1104.)

220 Emmett, P. H. Catalysis. Volume 6. New York, Reinhold, 1954. 706 p.

270 American Society for Testing Materials. 1958 book of standards, including tentatives. Part 2: non-ferrous metals. Philadelphia, Pa., ASTM, 1958. 1354 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

591. Oil discovery techniques. Anon. *World Oil*, 1959, **148** (1), 148.—Techniques used in the search for oil over the past 100 years are reviewed. The importance of surface geology was recognized after White proposed the anticlinal theory in the 1880s and improved mapping methods led to the finding of oil in structures mappable at the surface. Aerial photographs later enabled these structures to be more readily detected, and following the first world war subsurface geology, core drilling, and geophysical exploration have been intensively developed. Electric logging was a significant development, and in recent years the main developments have been in geophysics, particularly in seismic methods, where data processing, magnetic recording, and the use of high frequencies have enabled subsurface geology to be interpreted more accurately.

C. A. F.

592. Studies of ancient beaches provide clues in oil search. W. C. Thompson. *World Oil*, 1959, **148** (1), 227.—The lithology of the Permian Lyons sandstone, which produces in four fields (Black Hollow, New Winsor, Pierce, and Fort Colins), has been studied in outcrop in the Denver basin, Colorado. Bedding features, composition, stratigraphical relationships, and facies changes show that the formation compares significantly with similar features in modern beaches on the Californian coast, and it is considered that, as shore processes localize areas of clean sand with good permeability, the recognition of fossil beaches is useful for determining sites of oil accumulation.

Bedding in beaches is characteristically laminated with cross bedding; and minor features of deposition, such as lingoid ripple marks (due to wash by thin layers of water), and wash and scour marks on bedding planes are found. Arkosic lenses occur in the Lyons as channel infills due to "cut and fill." It is thought that the beach was preserved as a result of rapid subsidence, preventing erosion by wave base. An isopachyte map of the Lyons formation is included. 4 refs. C. A. F.

593. Experimental deformation of sedimentary rocks under confining pressure: tests at high temperature. J. Handin and R. V. Hager, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (12),

2892–934.—Short-time triaxial compression tests of dry anhydrite, dolomite rock, limestone, sandstone, shale, siltstone, slate, and halite single crystals under pressure–temp conditions simulating depths down to 30,000 ft reveal the following: (1) Invariably an increase of pressure at constant temp increases the yield stress, but an increase of temp at constant pressure reduces it. (2) An increase of pressure at constant temp always enhances the ultimate strength. However, heating at constant pressure may raise the ultimate strength by increasing the ductility of work-hardening rocks. More commonly, heating lowers the ultimate strength by eliminating work-hardening, so that even though a rock is more ductile, it is weaker because its yield stress is reduced. (3) In any event, for all materials tested except the halite, the ultimate strength at any simulated depth exceeds the crushing strength at atmospheric conditions. Below *ca* 15,000 ft the strength of halite is less than at the surface.

The effect of heating up to 300° C on the strength and ductility of anhydrite, dolomite, sandstone, and slate is small. However, the strength of limestone, shale, and siltstone at room temp exceeds that at 300° C by *ca* 50%, and of halite by nearly seven times. E. N. T.

594. Summary of oil occurrence in Anahuac and Frio formations of Texas and Louisiana. R. A. Burke. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (12), 2935–50.—More than 5 billion brl of oil have been produced from the Anahuac and Frio formations in the Texas and Louisiana Gulf Coast. The Frio, with many excellent blanket sands, accounts for practically all of this total; the Anahuac, which is primarily shale, produces only a small percentage from limited sand development. Oil activity on salt-dome structures in the Frio trend dates from the founding of the present oil industry with the discovery of oil at Spindletop and Jennings in 1901. Since that time, the oil industry has discovered approx 455 fields in Texas and 160 fields in Louisiana. A great variety of geologic structures, together with favourable sedimentation conditions, resulted in the formation of many traps for oil and gas in the Anahuac and Frio formations. E. N. T.

595. Organic materials of Early Middle Devonian, Mt Union area, Pennsylvania. F. M. Swain. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (12), 2858–91.—The name Newton Hamilton formation is here applied to the widespread shaly facies of the Onondaga group in Central Pennsylvania. The formation is divisible into two members: the Hares Valley dark grey shale and limestone member, above, a new name; and the Beaverdam Run dark grey shale, below, a name modified from the usage of Willard.

The bituminous materials of the Devonian shales in the Mt Union area range from 0·002 to 0·24% of the rock, with the Marcellus black shale containing the largest quantities. The bitumens, on separation by means of column chromatography, were found to contain fractions referable to saturated hydrocarbons, aromatic hydrocarbons, asphaltenes, and polar cpds.

Experiments with gas chromatography of the bituminous materials suggest that most of the column chromatographic fractions consist of cpds having carbon numbers above 20.

Upward from the Ridgeley sandstone to the Newton Hamilton, Marcellus, Mahantango, and Burket shales, the saturated hydrocarbons form an increasing percentage of the bitumens and of total hydrocarbons where the aromatic hydrocarbons decrease upward. This relation is believed to have a palæogeographic significance, resulting from the greater stagnation and poorer circulation of the Oriskany through Marcellus seas as compared with the Mahantango and Burket. E. N. T.

596. Palæozoic rocks of North-Central Nevada. R. J. Roberts *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (12), 2813–57.—Recent geologic mapping and stratigraphic study in N.-Central Nevada has increased our knowledge of the Palæozoic stratigraphy and structural history of this complex area.

E. Nevada differs greatly in stratigraphy and structural history from the W. part. In E. Nevada, roughly E. of longitudes 116°–117°, the Palæozoic rocks from Middle Cambrian to Upper Mississippian are mostly limestone and dolomite with minor amounts of shale and quartzite. In Central and W. Nevada the correlative strata are predominantly clastic sedimentary rocks and chert, with intercalated volcanic rocks and pyroclastics. The E. assemblage is of the order of 15,000 ft thick in most places; the W. assemblage is much thicker, probably more than 50,000 ft. The depositional environments of the E. and W. assemblages were clearly different. The E. assemblage is miogeosynclinal, the W. eugeosynclinal. The two have been brought into contact by telescoping along a thrust fault of great magnitude—the Roberts Mountains thrust—which carried the W. assemblage relatively eastward or southeastward over the E. assemblage.

In several places an assemblage that does not belong clearly to either the E. or W. assemblages, but includes elements of both, is recognized as transitional. E. N. T.

597. Stratigraphy of Cuyama Valley–Caliente Range area, California. M. L. Hill *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (12), 2973–3000.—The 1948 discovery of oil in Cuyama Valley has focused attention on the geology of this region. The development of stratigraphic data has necessitated the use of a number of new and redefined rock-stratigraphic terms. Therefore, the following names are submitted with the belief that their consistent usage will facilitate progressive geologic discussions and interpretations: Pattiway formation, Eocene (?); Simmler formation, continental Oligocene (?); Soda Lake sandstone, Soda Lake shale, and Painted Rock sandstone members of the Lower Miocene Vaqueros formation; Saltos shale and the redefined Whiterock Bluff shale members of the Lower and Middle Miocene Monterey formation; Branch Canyon formation, Middle Miocene; Caliente formation, continental Lower and Middle Miocene; Quatal formation, continental Upper Miocene; and the redefined Morales formation, continental Pliocene (?).

Other un-named Eocene and Cretaceous strata occur in the area, but the assignment of rock unit names would be premature here. Igneous and metamorphic rocks consist of pre-Upper Cretaceous granitic and gneissic types and Middle Miocene basaltic flows and sills. E. N. T.

598. Swan Hills find boosts Canada's reserves. A. Clark. *World Petrol.*, 1959, **29** (13), 58.—Recent drilling in the Swan Hills area, *ca* 125 miles NW. of Edmonton, Alberta, has established an important field with the Devonian Slave Point reef as reservoir rock. The productive area is uncertain, but preliminary estimates give a proved recoverable reserve of 80 million brl and 300 million brl probable. Much further drilling is required to define the productive areas in the district, and the terrain presents difficulties because of its rugged nature and cover of forest and muskeg.

Three wells have been drilled at Swan Hills, the best yielding an initial 55 brl/hr. The pay, which is at *ca* 8300 ft, varies from 35 to 155 ft in thickness and averages 9% porosity. A gas cap is unlikely, and water is probably present some way down dip. The Slave Point had not hitherto been found productive. C. A. F.

599. Recent studies of South Persian salt plugs. P. E. Kent. *Bull. Amer. Ass. Petrol. Geol.*, 1958, **42** (12), 2951–72.—In 1948–51 traverses of unexplored country near the Persian Gulf between Bushire and Lingeh during exploration work by the British Petroleum Co. permitted investigation of nine emergent salt plugs additional to those previously described. Two possible non-emergent plugs were also located. The geology of different types of the emergent plugs is described in

this paper, with emphasis on features of regional and genetic significance. A recent suggestion that igneous activity has played an important part in initiation of Persian salt-plug movement is not supported by the detailed studies. The stratigraphy of the associated rocks shows a clear distinction between those which reached surface by Middle Miocene or earlier and those associated with the Pliocene Zagros orogeny. E. N. T.

600. Franco Delhi exploration is under way in Algeria. Anon. *World Oil*, 1959, **148** (1), 252.—Photogeological work is being carried out on a 445,000-acre concession in the Sahara desert. The area is *ca* 75 miles E. of the Hassi R'Mel gas field, which has gas reserves reported to be over 11 trillion cu. ft., and *ca* 80 miles W. of Hassi Messaoud, which has reserves estimated at over 2 billion brl and is producing 43° oil. C. A. F.

601. Another Sahara strike made. Anon. *Oil Gas J.*, 12.1.59, **57** (2), 64.—The well Bordj NLI 2, 6 miles NW. of the northernmost gas well at Hassi R'Mel, has tested 50 brl/hr from a Triassic sandstone at 8200 ft. The Hassi R'Mel field covers an area of *ca* 30 × 18 miles; seven previous producers have been completed in the Cambro-Ordovician. J. C. M. T.

602. Philippine petroleum possibilities. C. A. Baird. *World Petrol.*, 1958, **29** (13), 49.—Five sedimentary basins are known in the Philippine Islands, and these contain Tertiary marine sediments locally showing oil and gas seeps. The Cagayan basin in N. Luzon has been extensively studied at the surface, and wells have been drilled on anticlines. Gas has been found in the Miocene at *ca* 4300 ft, and oil prospects in the basin are excellent. In the Central Plains (or Valley) basin in Central Luzon, airborne magnetometer and other geophysical surveys have been carried out. Two dry holes have been drilled, but there are many potential Lower Tertiary reservoir rocks. The Iloilo basin in S. Panay Island contains Tertiary beds up to 15,000 ft thick, and the basal section contains porous Miocene sands which have possibilities for stratigraphic traps. Several gas seeps have been found, and geophysical and geological surveys have been carried out. In the Cotabato basin in W. Mindanao there is an active oil seep, and geophysical surveys have been made; no wells have yet been drilled, but a conspicuous anticline is known. The Agusan–Davao trough in E. Mindanao also has surface anticlines, and there have been geological and airborne magnetometer surveys.

Fragmentary basins are known along the margins of several islands, and these are also being explored and developments are outlined. A concessions map of the Philippines is included. C. A. F.

603. Australian oil hunt. R. C. Sprigg. *World Petrol.*, 1958, **29** (13), 66.—The intensive exploratory activity in Australia which followed the Rough Range discovery in 1953 is declining, and only 20 wildcats were drilled in 1957. Results have been disappointing, but recent wells have enabled the country's potential to be more accurately assessed and have emphasized the paucity of geological data over the large basin areas. A promising development in 1957 was the finding of a series of large domes with surface expression and large closure in the Great Artesian basin of Queensland and S. Australia. These occur in the deeper parts of the basin, which contains Mesozoic rocks reaching 6000–8000 ft and overlapping Palæozoic beds. In marginal areas W. of the basin there are Cambrian bituminous shales and limestones which are possible source rocks. Oil shows have been found in over 100 wells in Queensland and S. Australia, in the Cretaceous, Jurassic, Trias, Permian, and Cambrian; and potential marine source rocks occur in Cretaceous and Palæozoic rocks. Thick permeable sandstones occur and many possibilities exist for structural and stratigraphic trapping. Faulting appears to be negligible except in marginal basin areas. The W. part of the Artesian basin is now thought to offer the best prospects for oil development in Australia. C. A. F.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

604. Offshore gas seeps detected quickly with new technique. Anon. *Oil Gas J.*, 1.12.58, **56** (48), 82–3.—Gas seepages from the sea floor can be detected and located by boat. Sea water is continuously analysed for dissolved methane by means of an i.r. analyser. Seeps can be detected several miles away, and rates of seepage as low as 0·5 cu. ft/hr have been detected. Apparatus is small enough to be used aboard a 22-ft boat. Surveys have been run at speeds of up to 12 knots. Cost of survey is *ca* 2 cents/acre in the case of a large area. J. C. M. T.

DRILLING

605. Drilling practices. Anon. *World Oil*, 1959, **148** (1), 159.—The history of development of oil-well drilling is described in detail, and it is shown that the most important developments have occurred since the 1920s. Until then drilling had been carried out by cable-tool methods, but the introduction of the rotary method led to rapid advances in drilling control, flexibility, and efficiency. This was assisted by standardization of equipment in 1924. The improvement in design of drilling bits is discussed, the use of higher bit weights enabling faster penetration rates to be obtained. Drilling fluids have also much improved in recent years, and it is now possible to combat successfully many of the formerly intractable problems, such as high-pressure salt-water flows and lost circulation, and to maintain mud properties at high temp in deep wells. Air and gas are now being successfully used as drilling media in many areas. Surface equipment has improved in many ways, and some of the new advances in drilling techniques have come as a result of offshore drilling. The latest development is underwater drilling, in which the wellhead equipment is set on the sea bed and there is remote control from a floating barge.

The increasing demand for oil has required an increasing number of wells, and drilling costs have risen at a higher rate. Total drilling costs in the U.S.A. rose from \$1½ billion in 1948 to over \$3 billion p.a. since 1955. C. A. F.

606. Shallow air drilling technique proves successful. S. N. Stearns. *World Oil*, 1959, **148** (1), 224.—Air drilling has proved successful for shallow wells in a water flood project in the Hogshooter field, Oklahoma. Drilling costs were reduced due to improved penetration rates and longer bit life, and water entry up to 100 b.d. was successfully combated. A portable rotary rig was used with piston type compressors rated at 600 c.f.m. at 125 p.s.i.g. 6¼-inch bits were used below 20 ft of 8¾-inch surface hole. Total drilling time from spudding to final casing averaged 46·4 hr/well; well depths ranged from 1078 to 1190 ft. Air was particularly useful for coring, and 100% recovery was obtained. Total overall savings over conventional drilling were approx \$400/well. Statistical data on the wells are tabulated. C. A. F.

607. Desert rig works on wheels. Anon. *Oil Gas J.*, 12.1.59, **57** (2), 82–3.—A self-contained drilling rig of 5000–8500 ft capacity has been built on five semi-trailers equipped with sand tyres for service in the Libyan desert. Specification includes two 60-kW generators for aux power and lighting, a workshop, and storage for machinery spares and fishing tools. Three 300-h.p. diesel tractors are used for moving the rig in eight loads, and it is claimed that the entire rig can be moved 20–30 miles and rigged ready to spud in an 8-hr shift. J. C. M. T.

608. Newest drill stem testing technique. C. D. Hatfield. *Petrol. Engr*, 1958, **30** (11), B60.—A new method of drill stem testing technique has been applied by Mene Grande Oil Co. which provides reliable information on: (1) average effective permeability within the drainage area of the well; (2) well bore damage or skin effect; (3) true formation pressure; and (4) well productivities.

In this technique certain assumptions are made about the properties of fluid and the character of the reservoir. These are: (1) the reservoir is infinite in size; (2) the flow in the well bore is radial; (3) reservoir is a single-phase fluid of low but constant compressibility; and (4) that the permeability, porosity, and net thickness of formation are sufficiently uniform to be expressed as average effective values. The point-sink solution for the equation of flow is the basis for the determination of pressure, permeability, and damage effect used in this paper:

$$P_e - P_w = 162{\cdot}6\ \frac{qu}{Kh} \log \frac{t+e}{e}$$

where P_e = pressure at infinite boundary, p.s.i.; P_w = pressure at well bore, p.s.i.; q = varying production rate, b.d.; u = visc, cP; K = permeability, mD; h = sand thickness, ft; t = flowing time, minutes; e = shut-in time, minutes. Various calculation steps necessary for the interpretation of experimental results are outlined and an example is given to illustrate the method. M. F. M.

609. Modern drill-stem testing. W. B. Bleakley. *Oil Gas J.*, 22.12.58, **56** (51), 58–63.—The practice of drill-stem testing is reviewed. Recent developments in this field include: a retrievable wire-line tester, an acid formation cleaner, a straddle-packer tester without anchor pipe, support for small packers to prevent extrusion in large boreholes, and a combination tool with inflatable packer for testing in open hole. These are described and illustrated. J. C. M. T.

610. Watch those log readings! J. K. Kerver and C. L. Prokop. *Oil Gas J.*, 15.12.58, **56** (50), 102–6.—Lab measurements confirm past suggestions that the presence of hydrocarbons in a sand may result in some reduction of the self-potential reading, especially when pore channels are small and salinity of interstitial water is low. Test pieces consisting of porous quartz filter material, and samples of a Spraberry shale and a Frio shaly sand were immersed in brine soln of different concn on opposite sides, and the potential across the test pieces was measured. Kerosine and paraffin (wax) were used to saturate the test pieces. In all cases the potential increased significantly at high oil saturations. J. C. M. T.

611. Effective porosity from microlog and microlaterolog data. E. T. Guerro and F. M. Stewart. *Oil Gas J.*, 22.12.58, **56** (51), 81–2.—Porosities of clean sands can be obtained from microlog and microlateralog data using the relation:

$$\phi = \frac{1}{1 - S_{or}} (0{\cdot}62\ R_{mf}/R_{xo})^{1/2.15}$$

where ϕ = porosity; S_{or} = residual oil saturation in flushed zone; R_{mf} = resistivity of mud filtrate in ohms m²/m; R_{xo} = resistivity of flushed zone. A chart is provided for finding R_{xo} for an 8-inch dia hole given the micro inverse and micro normal resistivity readings. In the case of the microlateralog R_{xo} may be assumed equal to the resistivity shown on the log. The microlog is suitable for porosities greater than 15%, the microlateralog for lower values. J. C. M. T.

612. Miniature rock bits simulate deep-well drilling. Anon. *World Petrol.*, 1958, **29** (13), 81.—Deep-well drilling is being simulated in the lab by using miniature rock bits approx 1¼ inches in dia in machines which reproduce pressures varying up to 15,000 p.s.i., approx equivalent to a max mud column pressure of 9·5 lb mud in a 30,000-ft well. The device is used for simulating bottom-hole formation and mud pressures in order to study the factors affecting rate of penetration. Results of tests have shown that, in highly permeable rocks, drilling rates decrease markedly with increase in difference between formation and mud column pressures. At a difference of 100 p.s.i., rates may be reduced to 60–70% of rates with no pressure difference. Overburden pressure showed a negligible effect on drilling rate in permeable sandstones. Loose sand can be difficult to drill with high pressure differences. C. A. F.

613. Chemicals in drilling mud. G. R. Gray. *Oil Gas J.*, 15.12.58, **56** (50), 90–8.—The nature and effects of additives currently used in drilling muds are reviewed. Additives discussed are barytes, bentonite, attapulgite, various lost circulation materials, quebracho, lignites, lignosulphonates, phosphates, cornstarch, sodium carboxymethylcellulose, natural gums, synthetic polymers, lime, alkalis and salts, surfactants, emulsifying agents, lubricants, corrosion inhibitors, and foam breakers. 64 refs. J. C. M. T.

PRODUCTION

614. Determining recoverable gas reserves. D. H. McLendon. *World Oil*, 1959, **148** (1), 213.—A rapid and relatively simple method of calc gas reserves is presented, and it is claimed that it gives reasonably accurate predictions provided basic reservoir data are known. Calc involve reservoir vol and conditions, producing conditions, and physical characteristics of the gas. Formulæ are solved by means of a nomograph which is given. This can be used for a volumetric or expansion type reservoir. A continuous expression is used for the nomograph, and the reservoir vol is determined first from the formula:

$$V_r = 43{,}560 \times A \times h \times Q \times S_g$$

where V_r = reservoir vol in cu. ft; A = producing area in acres; h = producing thickness in ft; Q = average % effective porosity; S_g = gas saturation in %. The gas vol at reservoir conditions is converted to standard conditions and the recoverable gas reserve in cu. ft. can be determined knowing the standard gas vol at abandonment. An example of the use of the chart is given. C. A. F.

615. Semi-logarithmic decline curves. R. I. Bradley. *World Oil*, 1959, **148** (1), 220.—The semi-logarithmic decline curve is useful for estimating reserves, assuming that there is no change in future producing conditions. It is shown that:

$$R = \frac{P - E}{D} \text{ and } n = \frac{\log P/E}{\log (1 - D)}$$

where R = reserves or future production, brl; P = current monthly production rate, brl; E = monthly rate at terminal period, brl; D = decline per month, % as decimal; n = time. Charts for simplifying the calc and an example are given. C. A. F.

616. How pattern efficiency influences secondary recovery of oil. B. H. Caudle. *Oil Gas J.*, 22.12.58, **56** (51), 77–80.—Efficient secondary recovery depends on the efficiency with which the injection fluid sweeps out the reservoir vol, as well as the efficiency with which it removes oil from such sand as it contacts. The pattern sweep-out efficiency depends on the ratio between the mobilities of the oil and the injected fluid. If the mobility of the injected fluid is higher than that of the oil, low sweep-out efficiency results, and vice versa. Sweep-out patterns have been studied in the lab using scale models and fluids of various mobilities, the progress of the sweep being followed using an X-ray and fluorescent screen technique, thus overcoming the disadvantage of electric analogues that

only pairs of liq of similar mobilities can be used. With a five-spot pattern, using the experimentally obtained values for sweep-out efficiency, assuming a producing gas–oil ratio of 25,000 : 1 or water–oil ratio of 20 : 1 at abandonment, and typical displacement efficiencies of 65% for water drive, 50% for LPG drive, and 100% for miscible gas drive, the ultimate recoveries in terms of oil originally in place for the three secondary recovery processes would be: water flood 65%; LPG drive 50%; miscible gas drive 60%. J. C. M. T.

617. Pfizer's Programme 20 yields flood data. W. E. Bell and J. K. Shaw. *Oil Gas J.*, 12.1.59, **57** (2), 84–6.—Tests on 354 water-flood and 92 disposal projects demonstrate the usefulness of citric acid in sequestration of iron. Citric acid added (in ratio of 3 : 1 or 4 : 1 to the iron content) to injected water prevents iron from clogging the sand. Best results are obtained when the citric acid is added at a point in the system where the iron is still in the ferrous state. Fair or poor response to citric acid treatment has been found in cases where ferrous sulphide has formed. This cpd is preferentially oil wet, and if traces of oil are present in the injection water even large excesses of citric acid or hydrochloric acid do not break down the sulphide, but addition of a detergent may be helpful. J. C. M. T.

OILFIELD DEVELOPMENT

618. Venezuela's oil industry is sound. Anon. *World Petrol.*, 1958, **29** (13), 44.—Recent exploration in Lake Maracaibo and the Gulf of Paria has been very successful, although production for 1958 is estimated to be 6% less than in the previous year. In the Lake several exploratory wells have had initial producing rates of over 5000 b.d., and in the Gulf oil has been found in the first Venezuelan offshore well which is reported to have flowed 1500 b.d. of 20° oil from two zones below 4000 ft. Long-range projects in progress in the country include pipeline schemes and a new refinery at El Palito, the terminus of the new line from Barinas. This line, which extends some 212 miles, is 20 inches in dia and was opened in 1958. C. A. F.

619. Conflict and promise in Colombia. E. Ospina-Racines. *World Petrol.*, 1958, **29** (13), 38.—Oil production in Colombia in 1958 is expected to average *ca* 127,000 b.d., approx the same rate as in 1957. 23 fields are producing, and the development of new fields promises increased output. The major fields are declining, but this should be offset by the expansion of recent discoveries, such as Cicuco, San Pablo, Palagua–Velasquez, and Ermitano.

The most important recent find is Cicuco, where, in Aug. 1958, ten wells were producing a total of 10,000 b.d. Five companies are operating in the country, the current activities of each being outlined, together with the economic aspects of the industry. Oil products consumption in Colombia is now 17 million brl/year, and this amount is supplied internally. C. A. F.

620. Brazil steps up drilling to increase production. Anon. *World Oil*, 1958, **147** (7), 168.—Active exploration is being carried out in the Amazon jungle of Brazil, and new oil production has been found in Alagoas, where 30 wells p.a. are expected to be drilled for some years. In mid-1958 Brazilian production was over 50,000 b.d., and an increase was expected. Refinery capacity is being expanded, and a new refinery at Manaos is expected to have a capacity of 7000 b.d. by 1960. C. A. F.

621. French firms score twice in Sahara. Anon. *Oil Gas J.*, 22.12.58, **56** (51), 53–4.—The known area of the Hassi Messaoud field, Algeria, has been extended 12 miles N. by a successful step-out well, DMG 57. Total depth of this well is 11,653 ft, and the pay is *ca* 100 ft thick compared with 400–500 ft in wells farther S. Six development wells are being drilled in the N. area. There are at present 18 producers in the field. Production is limited to 10,000 b.d. by pipeline capacity.

A probable new-field discovery was made at Ouan Taredert, *ca* 19 miles SW. of Edjele, which tested 2512 M.c.f. wet gas/hr from 4741 ft and 37 brl/hr of light crude from 4941 ft. This is the first Saharan well to yield oil from the Ordovician. J. C. M. T.

TRANSPORT AND STORAGE

622. Ocean transport of liquefied gases. L. von Szeszich. *Oil Gas J.*, 12.1.59, **57** (2), 76.—It is estimated that when a projected methane tanker travels 4500 sea miles, regasified methane at point of use would be at competitive prices in many parts of the world. Gases would be transported liquefied and at atm pressure around their b.p., thus occupying smallest vol, smallest ratio of container weight to that of gas is obtained, and space used more effectively. Costs for a specific case are given for liquefaction plant, ocean-going ships, and storage at terminal, and total $0·512–1·324 from M.s.c.f. G. A. C.

623. Needed: a good batch interface detector for pipelines. W. W. Holt. *Oil Gas J.*, 5.1.59, **57** (1), 134.—Operation of the 2377-mile main and lateral lines system of Plantation Pipeline Co., originating at Baton Rouge, presents problems in maintaining flow rates, measurement, and correct delivery. Sp. gr. and colour differences are among other methods, such as capacitance type detectors, recording viscometers, fl. pt. indicators, radioactive tracers, and refractive index differences. No instrument so far tested fulfils demand for reliability. G. A. C.

624. Interface detectors: still room for improvement. C. W. Blackburn. *Oil Gas J.*, 5.1.59, **57** (1), 133.—Phillips Petroleum Co. reviews use of several makes and types of interface detector for various applications. One method uses instrument to measure change in amount of radioactive energy penetrating the product, a caesium 137 capsule providing γ radiations.

Change in capacitance also used to detect passage of interface between salt water and hydrocarbon product; another method employs by-pass sampling to detect change in gravity.

Feature most lacking is reliability. G. A. C.

625. Building a 12-mile long pressure vessel. B. Quarles. *Pipe Line News*, 1958, **30** (12), 21.—Carnegie Natural Gas Co.'s new mixed gas system designed to move a mixture of coke oven and natural gas near Pittsburgh is described. This dual 55-inch o.d. line is unique in design and differs radically from all existing systems. It handles 250 million cu. ft/day of gas mixture without compression. The manufactured gas, a by-product of coking operations, is untreated and contains large quantities of tars, water, absorption oil, etc., and comes into the intake of system at around 200° F and 11 p.s.i.g. It has a calorific value of 581 B.t.u/cu. ft. Natural gas supply has a 1074 B.t.u/cu. ft. heat content. The stabilizing plant, designed for complete automatic controlled operation, will stabilize the mixture at a constant 800 B.t.u/cu. ft.

Each of the two lines is actually a 12¼-mile pressure vessel, shop fabricated to extremely close tolerances then assembled in the field. Pictures taken during installation work show the extremely complicated and challenging nature of the work. Details of welding, drip installations, cantilever spans on river, and other useful information are included in the paper. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

626. How to inspect and maintain fired heaters. P. von Wiesenthal. *Oil Gas J.*, 1.12.58, **56** (48), 103.—Four basic steps are necessary to assure safe operation of fired heaters at all times. These include regular inspection during operation, elimination of potentially dangerous operating conditions, a regular shutdown and detailed mechanical inspection, and repair or replacement of components not up to minimum standards.

Visual inspection should concentrate on appearance of the coil and refractory surfaces, also on condition of stack and breeching.

Warning signs in a heater include increased fuel-gas pressure, indicating excessive heat release or insufficient combustion air; positive-pressure at top of radiant firebox, indicating excessive firing rates; and pressure drop well below normal, indicating low flow rates.

Components requiring most time to repair or replace should be inspected first. A thickness test of all tubes should be conducted; ultrasonic equipment gives visible indication. Such inspection includes looking for signs of undue scaling and for hot spots. Pitting can be measured by calipering equipment. Such distortion and low temp corrosion should be watched for and corrective measures applied.

Refractories should be examined for cracks and these filled, and insulating firebrick walls examined. Stacks can deteriorate by burning sour gas, and undue blistering of stack paint indicates improper combustion conditions. G. A. C.

627. How to select and specify process equipment. Pt 2. D. J. Oriolo. *Oil Gas J.*, 19.1.59, **57** (3), 100.—Information is given to enable final overall specifications on equipment to be drawn up; the selection of equipment is a most important factor in process design of plant.

Equipment concerned in this article includes crystallizers, dryers, centrifuges, filters, size-reduction equipment, solids-handling plant, ejectors, and instrumentation. G. A. C.

ABSORPTION AND ADSORPTION

628. Desulphurization of gas-oil distillates by adsorption. (In English.) J. Varga and V. Hesp. *Acta Chim. Hung.*, 1958, **14**, 43–59.—Several adsorbants and solvents were tested for their suitability in adsorption desulphurization of two gas-oil fractions. Best results were obtained with silica gel as adsorbant and benzene as desorbant. Optimum temp range was 40°–60°. The column was regenerated by elution with pentane, thereby making a cyclic process feasible. For a "long" gas-oil cut of initial S content 0·8%, an ASTM chromatographic column gave a yield of 60% S-free, of 70% containing 0·14% S, and of 80% with 0·35% S. 12 refs.

G. W. T.

629. New charts determine separator capacity. V. Smith. *Oil Gas J.*, 5.1.59, **57** (1), 97.—Four charts are given for use with cyl, monotube, two-phase separators, both vertical and horizontal, determine capacity of conventional oil and gas separators. Field tests have verified reliability of the curves.

G. A. C.

CRACKING

630. Recent developments in refining. W. J. Newby. *J. Inst. Petrol.*, 1958, **44** (420), 411–419.—Steady demand for an increase in motor gasoline O.N., from 1952 onwards, has led to substantial process developments in the oil industry, including the introduction of cat reforming. Various processes available for production of high O.N. gasolines—cat cracking and reforming, alkylation and polymerization, isomerization and chemical treatments—are reviewed. Large quantities of hydrogen available from cat reforming processes have been utilized for desulphurizing and otherwise improving the quality of a wide range of petroleum products. The more important developments in these two fields are discussed within the context of W. European requirements.

A. D. S.

631. Transport of a catalyst in continuous flow. (In Russian.) I. M. Razumov and I. G. Fadeev. *Khim. Tekh. Topliva Masel*, 1958, (11), 15–20.—Experiments showed that transfer in a continuous flow could be applied to the circulation of a cat with different granule shapes. A significant carrying capacity could be achieved with low dia pipe. The material in the elevator moved in a dense mass and at low velocities and ensured little damage either to the cat or to the tube walls. A pressure of the order of 5–7 atm was required for a continuous lift to a height of 130–230 ft. P. H. S.

632. Platinum hydrocracking of pentanes, hexanes, and heptanes. C. G. Mayers and G. W. Munns, Jr. *Industr. Engng Chem.*, 1958, **50** (12), 1727.—Hydrocracking to lower mol. wt. paraffin is an undesirable side reaction of pentane–hexane isomerization over platinum–acidic oxide cat. In pentane processing, this hydrogenolysis occurs predominantly at the platinum sites of the cat, not at the acid sites. With *n*-hexane, it is accompanied by cracking at the acid sites. Both types of cracking appear to involve intermediate olefin formation. With *n*-heptane, acid cracking predominates.

M. F. M.

633. Catalytic endothermal cracking of natural gas. (In Italian.) G. H. Hellendoorn, J. H. Baars, and E. de Jonge. *Riv. Combust.*, 1958, **12** (11), 836–46.—The authors report a series of industrial scale tests conducted at the Hilversum gas works on cat endothermal cracking of natural gas. The results of the process, which features a catalyst heating cycle by combustion of natural gas in air and a cycle of natural gas conversion with steam, throw particular light on the importance of the following parameters: natural gas/steam ratio; steam superheating temp; composition, temp, and dimensions of catalyst; reagent mixture flow velocity. These results are collected in tables and graphs.

(Authors' abstract.)

HYDROGENATION

634. Catalytic hydrogenation of cracked petroleum distillates. (In English.) J. Varga and J. Szebenyi. *Acta Chim. Hung.*, 1958, **16**, 193–204.—Investigations on the dist and cracking of Nagylengyel crude oil indicated that the optimum temp of hydrodesulphurization was 420° under 25 atm of H_2 in presence of Co molybdates, 90% of the S present being removable. Treatment and reaction times were 120 and 60 minutes respectively. Cat used were comp of Mo, W, Co, Ni, Fe, Al, Ti, and Cr. At least 15 atm pressure is required for refining. Al_2O_3 was the most efficient cat. Using cracked gasoline with a WS cat at 420° and 25 atm, and in the presence of Co molybdate at 35 atm, a product of 0·01% S content was obtained. 22 refs. G. W. T.

635. Regeneration of hydrogenation catalysts with hydrogen. (In Russian.) S. P. Rogov *et al. Khim. Tekh. Topliva Masel*, 1958 (10), 29–33.—A silica–alumina–molybdena cat having 10% wt coke deposited on it was restored to high activity by regeneration with hydrogen under the following

conditions: pressure, *ca* 300 atm; temp, *ca* 450° C. After 100 hr under these conditions the coke on the cat had been reduced to *ca* 4% wt. A similar effect may be obtained under similar temp and pressure conditions by passing hydrocarbon fractions having a H_2/HC ratio of 15 : 1 over the cat.
P. H. S.

CHEMICAL AND PHYSICAL REFINING

636. Cost of solvent recovery systems. H. L. Barnebey and W. L. Lavis. *Chem. Engng*, 1958, **65** (26), 51–5.—Solvent recovery by activated carbon adsorption is becoming a process step of great economic importance. Air laden with solvent vapours in concn from a few p.p.m. to over 90% can be passed through beds of activated carbon, with subsequent steam dist of the solvent to recover it from the carbon bed. The authors show the cost data which permit a quick, approx estimate of capital costs, operating costs, and economic benefits of activated carbon solvent recovery systems. An example is given in the paper which illustrates the method. M. F. M.

SPECIAL PROCESSES

637. Dry adsorbers now open new sources of gasoline. C. S. Cronan. *Chem. Engng*, 1958, **65** (25), 72.—Commercial evidence points to the adsorption's re-entry into the field of hydrocarbon recovery from natural gas. Four American companies have, within the past two years, installed adsorption-based package units. Three of such units have fixed beds of solid granular adsorbent material and the fourth one, operated by Jefferson Lake Sulphur Co., uses a moving bed method. All four units utilize high temp (600° F) natural gas to regenerate the adsorbant material. Relatively small beds of granules used in modern units heat up rapidly for regeneration and also cool quickly down to adsorption temp.

Product recovery is good under favourable conditions, and 60–90% extraction of pentanes—plus fractions (less for butanes and propanes) are possible. Some commercial units are in operation, and operating costs of these are stated to be low compared to other recovery methods for hydrocarbons from natural gas. M. F. M.

PRODUCTS

CHEMISTRY AND PHYSICS

638. Qualitative investigations of vapour–liquid equilibria of the ternary system ethene–ethanol–water. (In German.) G. A. M. Diepen, D. T. A. Huibers, and H. I. Waterman. *BrennstChemie*, 1957, **38** (17–18), 277–80.—Difficulties in product separation in cat hydration of C_2H_4 to C_2H_5OH supply the motive for further studies of the heterogeneous vapour–liq equilibria between C_2H_4, C_2H_5OH, and H_2O. Results—discussed and presented in tables and triangular charts—were obtained in the simple Cailletet apparatus for temp 0°–90° C and pressures up to 100 atm. From the observations it appears feasible to employ C_2H_4 for C_2H_5OH extraction from dil aq soln, but the results obtained are not transferable directly to semi-tech or tech installations. There are indications that the ternary system C_3H_6–*iso*propanol–H_2O behaves similarly. 11 refs. R. T.

639. The densities of liquid C_3 and C_4 alkenes at temperatures above their boiling points. D. W. Morecroft. *J. Inst. Petrol.*, 1958, **44** (420), 433–4.—Liq densities of propene, *iso*butene, butene-1, cis-butene-2, and trans-butene-2, under their own vapour pressures, are reported over the temp range 0°–80° C.
A. D. S.

640. Some observations concerning the viscosity–temperature behaviour of hydrocarbons. W. C. Winning. *J. Inst. Petrol.*, 1959, **45**, 9–15.—Visc–temp characteristics of hydrocarbons are represented by the equation:

$$W = C - QZ$$

where W is a function of visc, C a constant characterizing the particular hydrocarbon, Q a measure of the visc–temp behaviour relative to that of *n*-alkanes, and Z a function of temp. For *n*-alkanes $Q = 1$, whilst for other hydrocarbons Q varies from 1 upwards. A. D. S.

641. Electric strength and high-field conduction current in *n*-hexane. A. M. Sletton. *Nature, Lond.*, 1959, **183** (4657), 311–12.—Data are presented on electric strength and high-field conduction current in *n*-hexane. Attention is drawn to influence of dissolved air, oxygen, and nitrogen on these measurements, and the high results previously reported are attributed to the presence of substantial amounts of dissolved oxygen in the *n*-hexane used. A. D. S.

642. Effect of low concentrations of alcohol on the interfacial tension between water and hydrocarbons. F. Franks and D. J. G. Ives. *Nature, Lond.*, 1959, **183** (4657), 316–17.—The effect of low concn of *n*-aliphatic alcohols on the interfacial tension of water against hexane and octane is discussed. Graphical results are presented. A. D. S.

ANALYSIS AND TESTING

643. Micro methods for analysis of petroleum. A. R. Jones and C. Liddell. *Analyt. Chem.*, 1958, **30**, 1570–5.—A scheme is presented for the fractional dist of 5 ml of crude oil. Procedures are described for tests on the dist and residue at each stage. These include an. pt., sp. gr., aromatic content, Br No., S, wax, pour point, and asphaltenes. Only simple apparatus is used, and the results are in good agreement with the standard macro methods. G. B.

644. Determination of arsenic in petroleum fractions and reforming catalysts. D. Liederman, J. E. Bowen, and O. I. Milner. *Analyt. Chem.*, 1958, **30**, 1543–6.—The method described is suitable for the determination of As in reformer feedstocks and cat in the concn range 0·001–0·05 p.p.m. in naphtha and 1–1000 p.p.m. in cat. The As is simultaneously extracted and oxidized, in feedstock by heating with H_2SO_4 and H_2O_2, and in cat by fusion with Na_2O_2. It is then distilled as $AsCl_3$ into HNO_3 and determined colorimetrically with ammonium molybdate. The standard deviation on naphtha samples is 0·0015 p.p.m. G. B.

645. Determination of saturate impurities in aromatics. J. C. S. Wood, C. C. Martin, and M. R. Lipkin. *Analyt. Chem.*, 1958, **30**, 1530–4.—A method based on the additive property of the refractive index is proposed for the determination of saturated hydrocarbons present as impurities in concn of 0·1–6% in aromatic cpds. Blends are prepared of the sample with *trans*decalin and with *iso*-octane. The aromatic cpd is removed by the ASTM Method D1019 and the refractive indices of the two blends and of the *iso*-octane and *trans*-decalin are determined. From these data the concn of the impurity and its refractive index can be calculated. The standard deviation for the values for % impurity is 0·024 and the reproducibility (95% fiduciary limits) is 0·07. The method is more precise and more sensitive than the present ASTM Method D851. G. B.

646. Urea addition to technical paraffins. (In German.) H. Schlief and E. Leibrutz. *Chim. Tech., Berlin*, 1958, **10**, 345–50.—A review is given of the theoretical basis of addition of

urea for separation of olefins from technical paraffins. Possible applications of the exchange effect are suggested, where short-chain *n*-alkanes, *n*-alkenes, *n*-fatty acids, and *n*-alcohols could be exchanged with long-chain *n*-paraffins. Technical uses of urea addition processes are described. G. W. T.

647. Pure paraffins and their binary mixtures. (In French.) S. Barbezet-Debreuil. *Compt. rend., Paris*, 1958, **246**, 2907–9. —This is a preliminary report on an X-ray diffraction study of the transition in the pure cryst paraffins (C_{18}, C_{22}, C_{26}, C_{32}, and C_{36}) and of the cryst of binary mixtures of pure paraffins. G. W. T.

648. A spectrographic method for determining barium in grease additives. (In Russian.) K. I. Zimina and L. G. Mashireva. *Khim. Tekh. Topliva Masel*, 1958, (8), 34–7.—Paper describes an optical method for determining Ba in greases, which is based on the use of quartz spectrograph ISP–22 with reference to the following Ba spectrum lines (A): 2335·3, 2347·6, 2304·2. In 15 parallel determinations, with the gravimetric method, average percentages of Ba found were 0·101 and 0·102 respectively. G. W. T.

649. Aromatic content of kerosine and gas-oil fractions. (In English.) T. Balint. *Acta. Chim. Hung.*, 1958, **15**, 139–49. —Paper describes a u.v. absorption method for estimation of *mono-* and *di*-cyclic aromatics in fractions of b.p. 180°–285°. *Mono*cyclics were estimated at 1900 and *di*cyclics at 2800 A, the mol extinction coeff (*I*) being determined at 1950 A. *I* was not constant, but decreased with increasing b.p. 22 refs. G. W. T.

650. Solubility of gases in petroleum oils at elevated pressure and temperatures. (In Russian.) T. P. Safronova and T. P. Zhuze. *Khim. Tekh. Topliva Masel*, 1958, (2), 41–6.—Solubility pressure equilibria at const temp were determined for methane, ethane, propane, carbon dioxide, and nitrogen dissolved in four Russian crude oils. Data were plotted for temp from 20° to 100° and pressures from 1 to 300 atm. A detailed drawing of the apparatus is given. G. W. T.

651. Infra-red absorption of solid state *n*-paraffins—relationship to crystalline type. J. M. Martin *et al. Spectrochim Acta.*, 1958, **12**, 12–16.—Studies were made of a number of pure *n*-paraffins (C_{17}–C_{35}) in the 650–800 cm^{-1} i.r. region. Differences were obtained between paraffins of odd and even carbon numbers at temp below that of the solid phase transitions. Spectra of the odd carbon number *n*-paraffin below C_{26} and both odd and even carbon number *n*-paraffins above C_{26} are characterized by a splitting of the 721-cm^{-1} band into a 718–728-cm^{-1} doublet. The even carbon number *n*-paraffins below C_{26} are characterized by a single absorption band at 715 cm^{-1}. G. W. T.

652. Organic sulphur compounds in Alberta cracked distillates. C. H. Amberg. *J. Inst. Petrol.*, 1959, **45**, 1–8.—A scheme for the rapid analysis of organic sulphur cpds in high-sulphur cracked dist is presented. The cpds are concentrated from fractionated samples by chromatography over alumina and analysed by a combination of G.L.P.C. and mass spectrometry. Sulphur cpds from dist cuts ex Lloydminster crude and Alberta bitumen are shown to be thiophenic in nature. A semi-quantitative estimate of 15 different thiophenes is obtained. A. D. S.

653. Determination of trace quantities of nitrogen in petroleum fractions. O. I. Milner *et al. Analyt. Chem.*, 1958, **30**, 1528–30.—Organic nitrogen cpds in petroleum fractions in concn of 0–5 p.p.m. poison the cat used in reforming. They can be extracted with H_2SO_4 and determined by the Kjeldahl method. The NH_3 produced is collected in dil H_2SO_4 and determined colorimetrically by reaction with NaOCl and phenol to form a blue indophenol (Noble, E. D., *Analyt. Chem.*, 1955, **27**, 1413, Abs. **93**, 1957). G. B.

654. Application of structural analysis to petroleum fractions with a high sulphur content. A. Camisa and C. A. Fratta. *Riv. Combust.*, 1958, **12** (11), 815–35.—The calculation of various parameters used in structural analysis methods was originally developed for fractions having a sulphur content up to 2%. The present study has been undertaken to ascertain whether the corrections introduced into such parameters could be applied also to crude oil fractions with a higher sulphur content (up to 7%). The experimental determinations and calculations have been carried out on sulphur-free fractions and blends with a sulphur content in the range of usual validity of the original methods. The data obtained on these blends have been extrapolated for higher sulphur content fractions. The work has shown that the corrections introduced in the original method were also applicable for higher sulphur contents. Furthermore, it was possible to ascertain that, also in this higher range of sulphur concn, $\%\ C_A$, R_A, and MW are not affected by the sulphur content and do not require a correction. (Authors' abstract.)

655. Separation of *m*-xylene and *p*-xylene by gas chromatography. D. H. Desty *et al. Nature, Lond.*, 1959, **183** (4654), 107–8.—Evaluation of stationary phases for separation of xylene isomers by gas chromatography has shown 7,8-benzoquinoline to be far superior to any other previously reported. A. D. S.

656. Gas odorants analysis by gas chromatography. C. F. Spencer, F. Baumann, and J. F. Johnson. *Analyt. Chem.*, 1958, **30**, 1473–4.—The mixtures of thiols and sulphides used as odorant additives in natural gas can be analysed with a precision of $\pm 5\%$ by G.L.P.C. with He as carrier and dinonyl phthalate as stationary phase. Relative retention times and vol and partition coeff are listed. G. B.

ENGINE FUELS

657. Determination of TEL in leaded fuels. (In Russian.) V. S. Dmitrievskii. *Khim. Tekh. Topliva Masel*, 1958, (11), 59–61.—A given amount of fuel was boiled with iodine soln, cooled, and filtered. The precipitate was dissolved in hot ammonium acetate. To this was added potassium tartrate, a buffer soln, and a previously prepared soln of Chromogen Black Special ET–100, as indicator. The mixture was then titrated against Trilon-B until the colour changed from red to violet-blue. The amount of TEL in the original fuel could then be calculated by a special equation. P. H. S.

658. Determination of thermal stability of fuels. (In Russian.) G. S. Shimonaev *et al. Khim. Tekh. Topliva Masel*, 1958, (4), 46–51.—Methods and results with five fuels are described. The fuel was filtered and poured into two 25-ml flasks, which were then heated at 200° C for 20 minutes. After cooling, the fuel was passed through a standard glass wool filter with a vacuum pump, and the filter washed, dried, and weighed to find the quantity of deposit resulting from the heating. Comparative tests were made with the U.S. Erdco apparatus. G. W. T.

659. High-energy hydrocarbon fuels. J. Happel and C. J. Marsel. *Chem. Engng Progr.*, 1958, **54**, 60–4.—Hydrocarbons of the C_3H_8 and *cyclo*propane families, by virtue of their extra energy, yield fuels which have higher specific impulses and increased reactivity (resulting in smoother combustion in engines) than conventional aircraft fuels. Possible methods of producing such fuels are reviewed, and several commercial processes are reported. G. W. T.

GAS OIL AND FUEL OIL

660. Catalytic hydrogenation of sulphur compounds of a sulphur-containing mineral oil distillate. (In English.) J. Varga *et al.* *Acta Chim. Hung.*, 1958, **14**, 133–40.—Conversion of five cpds of a mineral oil dist containing 0·49% S was studied at 400° and H_2 pressures of 10 and 40 atm. Cat employed were Fe_2O_3, Cr_2O_3, MoS_2, WS_2, Co molybdate, and a mixture WS_2–NiS–Al_2O_3, 27 : 3 : 70. WS_2 and the mixed cat were the most effective and gave complete desulphurization at 400° and 40 atm. Dilution with tetralin promoted S removal, producing complete desulphurization with Co molybdate and the mixed cat at 10 atm and 450°. 13 refs. G. W. T.

LUBRICANTS

661. Optimum methods for oil-jet lubricating jet-engine main-shaft ball bearings. R. E. Murteza. *ASME Paper* No. 58–A–258, 1958.—Variations in oil-jet lubricating techniques were studied under controlled conditions in a 110-min-bore main-shaft bearing test rig. Test conditions were similar to those encountered in present-day jet engines, with the exception of temp, which purposely were not simulated to simplify the tests. Reported temp were those generated by the bearing only. Performance under the various test conditions was characterized by bearing operating factors such as torque, self-induced inner and outer-ring temp, and quantity of transmitted oil, *i.e.* that fraction of the total introduced oil flow which actually flows through and emerges from the opposite side of the bearing. G. W. T.

662. A study, using radioactive lubricating oil, of the oil consumption in an operating diesel engine. M. Pobereskin *et al.* *ASME Paper* No. 58–A–143, 1958.—Six experiments on lub oil consumption, using radioactive oil, were conducted on an operating diesel engine to determine a possible correlation between break-in wear and oil consumption. In addition, oil consumption was investigated as a function of engine load, speed, temp, and piston-ring configurations. These experiments, in general, proved the feasibility of using tracer techniques in determining oil consumption under various operating conditions. G. W. T.

663. Diesel engine lubricants: their selection and utilization with particular reference to oil alkalinity. A. Dyson *et al.* *Proc. Instn mech. Engrs*, 1957, **171**, 717–30, discussion 731–40.—During the combustion of fuels containing S, S acids are formed which have a deleterious effect on engine parts and lub oils. One method of neutralizing these acids is by the use of alkalysed oil additives. Data are presented relating engine wear and cleanliness during use to the change in alkylation of the oil. It was found that the engine remained clean as long as a minimum alkylation existed. From these data equations were derived relating the oil-change period to the alkylation conen of both the crankcase and make-up oils. G. W. T.

664. A radiotracer counting method for engine wear determination. E. H. Okrent and G. A. Weisgerber. *ASME Paper* No. 58–A–247, 1958.—This paper presents a technique for determining engine wear using irradiated engine parts and discusses in detail the physics of the counting system and the used oil matrix. Two major topics are included, a discussion of counting techniques, followed by the application of these techniques to a determination of hardenable cast-iron valve train wear rates of some commercial lubricants. This type of valve train was selected as the example for the counting discussion, since refinement of counting techniques was required in order to measure this wear reproducibly. G. W. T.

665. A review of some recent advances in lubrication of railway car journal plain bearings. R. F. Meeker and D. C. McGahey. *ASME Paper* No. 58–A–266, 1958.—Discusses some of the aspects and problems associated with the operation of railway-car journal plain bearings from a lubrication standpoint. The subject is considered with respect to fundamental characteristics of plain bearings, full-scale lab testing, lab bench testing, wicking characteristic of lubrication devices, oil visc, and oil quality. G. W. T.

666. Dialkyldithiophosphates of metals as complex additives for lubricating oils. (In Russian.) P. I. Sanin *et al.* *Khim. Tekh. Topliva Masel*, 1958, (8), 24–8.—The Ba salt of this acid (DF-1) proved in a series of basic experiments on the properties of lub oils to exert a positive influence. It improved the detergency of the oil, lowered its corrosive action, raised its stability, and lowered the solidification point of paraffin oils. Its action depended upon the comp of the oil and the conen used. Optimum addition of DF-1 was *ca* 3%. G. W. T.

667. The flow of lubricating greases. A. W. Sisko. *Industr. Engng Chem.*, 1958, **50** (12), 1789.—The flow characteristics of lub greases in capillaries and pipes has been investigated over a wide range of shear rates. The data lie on a single smooth curve and are fitted by a new equation:

$$F = a\gamma + b\gamma^n$$

where a, b, and n are constants and $\frac{F}{\gamma} = \mu$, where μ is the visc.

Tests of the Buckingham equation and the three-parameter Ree–Eyring equation show that they do not adequately describe grease flow.

The new equation can be used to calculate pressure drops in pipe flow and to explain the appearance of plug flow in greases. The constants of equation are useful in characterizing greases and writing specifications. M. F. M.

BITUMEN, ASPHALT, AND TAR

668. Mixtures of petroleum bitumen with Trinidad asphalt. (In German.) — Steinhilber and — Schirott. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (10), 360–1.—Bitumen–Trinidad mixtures show no improvement compared with pure bitumen of the same softness. Higher Trinidad asphalt additions, giving higher soft. pt., point of refraction, pen, and duct, are detrimental, which indicates the necessity for Trinidad asphalt limitation to a quantity in line with requirements for an asphalt concrete. A larger quantity of Trinidad asphalt requires a much softer petroleum bitumen for admixture. That more bitumen may be accommodated in the mineral mass by adding Trinidad asphalt over against petroleum bitumen of the same softening and pen degree may apply for a petroleum bitumen of low asphaltene cont, but should not be generalized in this form. Following the statement that more binder could be accommodated formerly, necessary data fail on binder type, and especially on grain size and structure of the mineral masses. In bitumen–Trinidad mixtures practically no improvements in bending strength—in part pure bitumen gives better results—are obtained. Results with asphalt concrete give no conclusive evidence of improvement of petroleum bitumen by Trinidad asphalt addition. A further influence on the properties of asphalt concrete is filler type and quantity. R. T.

669. New method for quantitative determination of the shrinkage process of stone coated with bituminous binders on water storage. (In German.) K. Letters. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (12), 415–20.—Shrinkage of bitumen-coated stone in water storage—formerly observed visually—is estimated quantitatively. Conformity to regularity, according to Fick's Law No. 1, exists between solubility in unit time and surface dimension. With model investigations, using coatings on glass plates of known surface, former observations

—that small surface reduction expresses diminution of dissolved substance—were confirmed. Using a good solvent, with vigorous stirring for a short immersion time, the dissolved substance bears a simple relation in proportion to surface size. Using standard basalt (8–12 mm), the water-stored shrunken samples first show an unexpectedly high solubility attributable to a surface catalysis. This could be curbed satisfactorily by pre-dehydration with CH_3OH and a short immersion time. A series of cutback bitumens with and without adhesive was tested, and val obtained which—with variations *ca* 10% of the mean val—permit a clear and usable characterization of the phenomena. Since—under the same conditions—a layer of const thickness is dissolved from the surface, with the aid of model investigations with known surfaces, the still unknown surface size of normal basalt 8–12 mm was determined at 0·46 m^2/kg, thereby indicating a new method for general mineral surface determination. 14 refs. R. T.

670. Experiences in bituminous road construction. (In German.) — von Skopnik. *Bitumen, Teere, Asphalte, Peche*, 1957, **8** (10), 352–7.—Experiences in development of bituminous road construction are reported with 109 lit. refs. R. T.

SPECIAL HYDROCARBON PRODUCTS

671. Less moisture means faster cake-moulding. S. F. Kandra and W. D. Manz. *Oil Gas J.*, 5.1.59, **57** (1), 113.—Summertime dew points in the Gulf Coast area range in the mid 70's, and condensation was excessive during frequent periods of high humidity, moisture condensing on wax cakes during continuous moulding process. Air conditioning as a solution was not considered because of high costs.

Magnolia Petroleum Co. solved problem by coating moulding pans with silicone preheating pans before filling, and by minor equipment changes. De-moulding now takes place at 85° F, at which temp cakes are sufficiently above dew point to prevent moisture condensation. G. A. C.

DERIVED CHEMICAL PRODUCTS

672. Some problems of petroleum chemistry and the petroleum chemicals industry. (In Russian.) A. V. Topchiev. *Neft. Khoz.*, May 1958, 1–8.—A review is given of useful reactions and processes. Development is foreseen in chain and free radical reactions, where much theoretical work has been done, but industrial application has not kept pace, and in catalysis, where the theoretical work has been left behind. Note is also made of the use of nuclear radiations in synthesis and other processes, including the polymerization of ethylene, propylene, and *iso*butylene. G. W. T.

COAL, SHALE, AND PEAT

673. New method for processing oil shales. J. Grindrod. *Petrol. Times*, 16.1.59, **63** (1603), 29.—A method has been developed by the Denver Research Institute, Denver, U.S.A., using a 24-ton/day pilot plant to process oil shale deposits to yield liq fuel at competitive costs. In the Aspeco process retorting and combustion are separated. Heated metal or ceramic balls, " thermospheres," are transferred to the retort and mixed with the raw shale, thus producing shale oil vapours; the cooled thermospheres are returned to the furnace with the coke for reheating.

The use of a rotating drum for retorting permits more rapid conversion of kerogen to shale oil, the latter apparently so fluid that it could be put through pipeline without further processing. Since heating is in absence of air, formation of undesirable products is reduced and by-product gases of high heating value are obtained.

A flow diagram of the Aspeco process is given. G. A. C.

674. Studies in shale oil. Pt IX. Further data on emulsions and sludges. G. E. Mapstone. *J. Inst. Petrol.*, 1959, **45**, 16–17.—Sludge accumulated in crude oil storage tanks is stabilized by waxes, asphaltenes, and dust. Heating sufficiently allows the waxes to melt and the asphaltenes to coagulate and settle out with the dust, thus allowing the sludge to be resolved. A. D. S.

CORROSION

675. Failure of steel-admiralty duplex condenser tubes by hydrogen penetration. H. A. Honkala and E. A. Wright. *Corrosion*, 1957, **13**, 501–4t.—Inhibited admiralty alloy tubes, in propane condenser service, were found to fail from the shell side after two years, and 4–6 Cr steel tube replacements also failed after two years, but from the tube side (water side). 1010 steel–admiralty duplex tubes were then used, but in their third week their condensing capacity fell off rapidly and a visual inspection showed that *ca* 85% of the liners had collapsed away from the steel. It was thought that this was probably because of the high H_2S content of the process stream. Tests to investigate this attack are described. These showed that hydrogen diffusion through the steel in duplex tubes would result in collapse of liners. Moist H_2S attacks the steel, releasing atomic hydrogen, which diffuses through the steel until it reaches a discontinuity, such as a bond between tube and liner, where it forms molecular hydrogen, causing a rapid pressure build-up. Some preventive measures are listed: reducing the corrosiveness of the environment; injecting air to prevent hydrogen penetration; using materials more resistant to the process stream; and using a barrier on the exposed surface. F. M. G.

676. Service experience of glass-reinforced plastic tanks. NACE Tech. Unit Cttee T–1J. *Corrosion*, 1957, **13**, 459–60t.—A tension failure at one of the staves necessitated the scrapping of a glass mat-reinforced polyester oilfield tank after 46 months' service. Previously reported circumferential measurements over three years showed little difference between an empty and a full tank. Circumferential measurements of glass-epoxy tanks are reported, and these tanks appear to be quite satisfactory. F. M. G.

677. Corrosion in light oil storage tanks. E. H. Tandy. *Corrosion*, 1957, **13**, 427–32t.—In finished oil tanks near the coast, variation in corrosion, with shell height (max corrosion in cone-roof tanks at 60–80% height), API gravity of oil, size, and location is discussed, together with scale composition and corrosion mechanism in gasoline tanks. Water is usually present in tanks, and oxygen is more plentiful in the upper than in the lower regions, but this does not wholly account for increased corrosion in the upper shell courses. It is believed that this is caused by the absorption, by the scale, of oxygen-carrying condensate when the level is low. Temp effects, above and below the oil level, are discussed. Floating-roof tanks behave similarly to cone-roof tanks, the lower supply of oxygen from the vapour space being offset by the increased supply from the annulus round the roof. API recommended design figures for all-welded tanks give least corrosion allowance where corrosion is greatest; it is suggested that altera-

tions would increase tank life. Water removal is difficult, but corrosion control can be effected by reduction of oxygen by: (1) gas blanketing; (2) pressure storage; (3) inhibitors, and (4) some breathing systems. Gunnite has given good results as a coating, but paints fail rapidly when submerged. F. M. G.

678. Conical tube sheet combats corrosion. L. Resen. *Oil Gas J.*, 22.12.58, **56** (51), 72.—An inverted conical tube sheet mounted at bottom end of heat exchanger at the Ras Tanura refinery of Arabian American Oil Co. relieved a difficult sludge problem by trapping the corrosive sludge particles. Intermittent operation of a blowdown line prevents excessive sludge accumulation.

Diagrams show arrangement of device. G. A. C.

679. Experience with oilfield extruded plastic pipe in 1955. NACE Tech. Unit Cttee T–1J. *Corrosion*, 1957, **13**, 461–5t.—56 answers to a questionnaire on oilfield extruded plastic pipe have been summarized and assessed. Experience of failures, costs, intended purpose of pipe, reasons for not using plastic pipe, and information required by small users and non-users are discussed. Major uses are in low-pressure and salt-water systems. Large users seem to suffer a lower proportion of failures than small users, possibly because the larger users have gained more experience. Poor glue joints, the largest cause of failure, and poor installation may be corrected with experience. A large number of failures occurred under conditions of low safety factor. Main data required by small users and non-users are physical properties and installation costs. F. M. G.

680. Gamma-rays + X-ray films = a new way to detect corrosion. E. G. Pauschenwein and P. C. Trounce. *Oil Gas J.*, 22.12.58, **56** (51), 64.—Canadian Oil Co. at Sarnia refinery uses a combination technique involving γ-rays and X-ray film to record and plot corrosion with accuracy. The X-ray film is placed at the back of the pipe being examined, with the film at a predetermined angle for each pipe size; the source of γ-ray is then placed at a calculated distance from the pipe, and exposure time is carefully established.

From the unexposed area on the developed film the exact thickness of the wall of the pipe can be determined.

Prime application is to detect metal loss, but can be used for other inspection work. G. A. C.

681. Corrosion of mild steel in aqueous monoethanolamine. H. R. Froning and J. H. Jones. *Industr. Engng Chem.*, 1958, **50** (12), 1737.—Factors affecting attack on mild steel by aq monoethanolamine soln have been studied. These included temp, presence of contaminants, and concn of amine, carbon dioxide, and hydrogen sulphide.

Corrosion was more severe with high amine concn, and at a given set of conditions increased with temp. Hydrogen sulphide was most corrosive at low concn. Carbon dioxide was more corrosive than hydrogen sulphide and most corrosive at intermediate concn. When both were present, the corrosion rate was largely determined by the hydrogen sulphide concn. Small amounts of soluble silica inhibit corrosion in carbon dioxide–amine systems.

Service life cannot be predicted from these data alone, as other variables contribute to localized attack. M. F. M.

682. New stainless better than type 316. R. B. Norden. *Chem. Engng*, 1958, **65** (25), 194.—An improved stainless steel—D 319—with superior corrosion resistance as compared to type 316 is now commercially available. It has a higher chromium and molybdenum content and is more resistant to sulphuric, formic, and phosphoric acid and also to pitting and pinhole corrosion. The composition of the new steel is given as: Cr 16–18%, Ni 10–14%, Mo 2–3%, C max 0·08%, Mn 2·0%, Si up to 1·0%, P up to 0·045%, and S up to 0·03%. M. F. M.

683. Consider non-oxidative corrosion. R. V. Jelinek. *Chem. Engng*, 1958, **65** (26), 56–60.—By non-oxidative attack is meant the type of attack in which physical solution and diffusion predominate and chemical reaction is not the major cause of destruction. This is the case in corrosive attack by liq metals.

Several types of corrosive attack occur when liq metals contact solid metals, and these are: (1) simple solution; (2) alloying between liq metal and solid metal; (3) intergranular penetration; (4) impurity reactions; (5) temp-gradient mass transfer; and (6) concn gradient mass transfer. Variables affecting these phenomena are temp level, temp gradient, cyclic temp fluctuations, and surface to vol ratio.

The paper describes in detail the types of liq metal attack, the liq metal corrosion tests, and methods of controlling this type of corrosion. At present the principal means of controlling liq metal corrosion is to use construction materials which are known to be resistant. Some thought has been given to the development of inhibitors, such as scavengers to remove impurities or film-forming substances to set up diffusion barriers at solid surfaces. Barium, strontium, and calcium have been proposed as scavengers for molten sodium systems and titanium for lithium systems. M. F. M.

ENGINES AND AUTOMOTIVE EQUIPMENT

684. Volatility tolerance of passenger cars in the mountains. A. P. McCloud and J. N. Barker. *SAE Paper* No. 104C, 1958.—Most of the literature on vapour lock which is based on experimental data covers conditions from sea level to an altitude of only 3000 or 4000 ft. This paper attempts to fill the gap with data taken at six different elevations ranging from 1100 to 11,400 ft. In addition, a method of analysing vapour lock data taken at various altitudes is presented. G. W. T.

685. Measuring the hot fuel handling characteristics of automobiles. C. J. Brady and D. R. Johnson. *SAE Paper* No. 104A, 1958.—The paper describes test objectives, basic rules governing the tests, the preparation of test vehicle, test instrumentation, test fuels, data about climatic test conditions and correction factors, test driving schedules, and data evaluation methods. Typical vehicle hot fuel handling characteristics, as determined by actual test when using the method described, are illustrated. The procedure has been of great value in eliminating many problems prior to and after the production of a vehicle, and it is predicted that investigations in this field will be even greater in the future because of the increasing complexity of many factors that have a direct bearing on the problem. G. W. T.

MISCELLANEOUS

686. Hydrocarbon oil duties in 1957–58. Anon. *Petrol. Times*, 16.1.59, **63** (1603), 47.—Extracts are given from the 49th report of the Commissioners of H.M. Customs and Excise for the year ended 31 March 1958. Revenue fell from £338 to £322 million, and tables show receipts from hydrocarbon oil duties and quantities of oils retained for home consumption with net custom receipts, and figures for dutiable indigenous hydrocarbon oil. G. A. C.

687. United Kingdom petroleum legislation in 1958. V. Biske. *Petrol. Times*, 30.1.59, **63** (1604), 68.—Among legislation concerning petroleum products the Oil in Navigable Waters Act 1955 enables surveyors to examine ships in British harbours, and countries which have accepted the Convention are listed.

The system of classification of goods for customs purposes has been revised. Minor amendment to the regulations concerning safety permits larger max size of vessels for conveying spirit by road (other than in tank wagons or trailers).

The Alkali Works Regulations Act has been extended to include acetylene, and works in which gas is produced from oil are included in the Act.

Certain judicial decisions are also outlined. G. A. C.

688. Automatic computation speeds pipeline—investment analysis. T. R. Young. *Oil Gas J.*, 12.1.59, **57** (2), 69.—Computation concerns basic design of a projected line and estimation of constructional and operational costs, from which data the proposed investment may be evaluated to give figures for cash outlay, receipts, payout time, and investment yield.

A sketch gives a representative pipeline system showing multiple points of crude receipt and destinations. Tables show tariff required for various investment returns and nomenclature is given. G. A. C.

689. Air pollution by diesel fumes. U. F. Hannay. *Petrol. Times*, 30.1.59, **63** (1604), 72.—It is shown that increased air pollution by diesel fumes could be a contributory factor to account for the increase in cancer in recent years.

A Government committee reported in 1954 that there was an increased pollution of the atmosphere by motor traffic and that "the smoke from diesel exhausts can be a serious nuisance."

Diesel fumes contain considerable concentrations of 3 : 4 benzpyrene, a dangerous carcinogen. Papers on air pollution in diesel bus garages tended to show that it was less injurious to health to inhale the fumes of a London bus garage than to inhale the apparently clean air on the roof, and an unfortunate bias was introduced.

Although engineers state that properly maintained diesels emit no visible smoke, benzpyrene is a constituent of diesel exhaust. If the health of the community is to be maintained, the acts should be enforced. G. A. C.

690. Flare stacks—how tall? E. T. Bodurtha, Jr. *Chem. Engng*, 1958, **65** (25), 177–80.—Complete design of flares involves a number of important considerations, such as height, tip configuration, pilot burners, ignition systems, and smoke reduction. This paper considers the selection of flare stack height only.

Various techniques are available for computing stack heights needed for adequate disposal of contaminants such as that proposed by Bosanquet and Pearson. These techniques are described in the paper. For design purposes the highest p/q (ratio of vertical to horizontal atmospheric dispersion coeff) occurring with average or moderate turbulence is *ca* 0·63 and the minimum required flare stack height for any given max tolerable ground level concn (C_o) from the safety standpoint can be calculated from

$$h_s = \frac{(1{\cdot}35\,Qm \times 10^5)^{0{\cdot}5}}{[u\,C_o\,(\max)]^{0{\cdot}5}} - h_v - h_t$$

where Qm is contaminant emission rate at atmospheric pressure and temp, u is mean horizontal wind speed, and h_v and h_t represent the velocity rise and temp rise of gas from the top of stack.

The reliability of methods of design proposed by various investigators is discussed in the paper and a sample problem for moderate stack gas exit speeds is included to facilitate the understanding of the design method. M. F. M.

BOOK REVIEWS

Habitat of Oil: A Symposium. Ed. Lewis G. Weeks. Tulsa: American Association of Petroleum Geologists, 1958. Pp. viii + 1384. Members, $9, non-members, $11.

The Drake well, drilled a hundred years ago, is commonly looked upon as marking the birth of the modern oil industry. Petroleum geology began to grow from that date. Although its growth cannot be measured as simply or definitely as oil output, there is little doubt that it has been broadly like the build-up in annual oil output. However, the growth has not been uniform; there have been more or less static periods, and also phases of rapid expansion when new ideas have been developed and added to those already in use in the search for and exploitation of oil reserves. Certain fundamental problems have yet to be solved, but in some cases the past few years have seen developments which may contribute importantly to providing solutions.

In some areas the rocks are well exposed, and surface mapping or photogeology can give excellent records of their surface distribution, as well as indications, varying in certainty, of their subsurface distribution and form. Other areas may provide much less helpful surface evidence. Wells, by recording the vertical distribution of the rocks at a series of points and providing some types of information not obtainable from exposed rocks, give more definite data for the three-dimensional picture. The search for oil has led to wells being drilled in many areas. These wells, together with surface and other data, have yielded general pictures of rock distribution and form and of the geological history, as well as very detailed pictures for limited parts of the areas examined.

The formation and evolution of sediments are matters of prime importance in petroleum geology. Consequently, those concerned with the oil industry have encouraged investigations on a wide range of problems involving sediments and sedimentation.

"Habitat of Oil" presents information and ideas which are indicative of the present status of some aspects of petroleum geology and also of its very considerable achievements in certain directions. It should receive the attention not only of petroleum geologists but also that of other workers concerned with sediments, sedimentary basins, and

the structures associated with them. The title, although appropriate, may cause the book to be overlooked, by the latter group.

Most of the articles deal with the geology and the occurrence of oil in various sedimentary basins or in more restricted areas. There are 20 such articles on North America, five on South America, seven on Europe, five on the Middle East, and four on the Far East. Five articles deal with modern basins and their sediments, and nine with a range of general topics such as organic matter in source rocks, hydrocarbons in recent sediments, hydrocarbons in subsurface waters, oil migration in recent sediments, facies control of oil occurrence, and the mechanics of basin evolution. Lewis G. Weeks, the editor, ably reviews the series of articles, particular attention being paid to about 20 points, ranging from basin evolution through deposition rates, faults as barriers to migration, identification of an oil's source, bacterial activity and hydrodynamic control of oil occurrence, to carbonate dolomitization and recrystallization.

Such is a brief indication of the contents of some 1300 pages. A wealth of information and ideas is presented. Some of the ideas may not be acceptable to all readers, but they may nevertheless be most stimulating. For example, in one place it is suggested that there is " the need for a reappraisal of criteria of sedimentary environments," and that " the repudiation of many traditional criteria will require the rewriting of a significant portion of historical geology. Thus, basic principles of petroleum geology are at issue."

This is a book to be dipped into. Some parts can be digested easily; others need slow assimilation, occasionally because of obscure style.

" Habitat of Oil " can be thoroughly recommended, and the editor and his associates deserve congratulation on the successful completion of a Herculean task. G. D. H.

Gas Chromatography 1958. Ed. D. H. Desty. London: Butterworths Scientific Publications, 1958. Pp. xv +383. 70*s*.

This book contains the papers presented at the second symposium organized by the Gas Chromatography Discussion Group under the auspices of the Hydrocarbon Research Group of the IP and the Koninklijke Nederlandse Chemische Vereniging. The symposium was held at Amsterdam from 19 to 23 May 1958. 28 papers were presented at the symposium, which was divided into three sections. The opening remarks by the section chairmen and a full discussion of the papers are also included in the book.

The first section, which deals with the theory of gas chromatography, contains ten papers. Half the papers in this section deal with the conditions necessary for the attainment of high column efficiencies in both packed columns and coated capillary columns.

The nine papers in the second section are concerned with technique and apparatus. The first part is devoted to detectors and a detailed discussion of the flame ionization detector is included. Among the topics dealt with during the second part is the construction of very efficient packed columns, a comparison of stationary phase supports, the use of multiple columns, and programmed heating.

The third section is concerned with the applications of gas chromatography to specific problems. Of the nine papers in this section only one deals with the analysis of petroleum.

It is interesting to note the progress made since the first symposium which was held at London in 1956. The development of very sensitive detectors and highly efficient columns has been a major achievement. Progress in the application to high molecular weight petroleum fractions has been slower than was expected, probably mainly due to difficulties in identification. The discovery of new stationary phases has also been slower than expected, but this has become of less importance now that such efficient columns are available.

One rather disappointing feature of the book is the almost complete lack of papers on methods for increasing the precision of routine gas chromatographic methods. Another problem that causes difficulty, the identification of peaks from complex mixtures, receives little attention.

The book is an important contribution to the literature of gas chromatography, and will be found to be indispensable to workers in this field. It is well produced, contains few misprints, and is good value for money. P. I. B.

Vapour–Liquid Equilibrium. Eduard Hala, Jiri Pick, Vojtech Fried, and Otakar Vilim. Trans. Dr G. Standart. London: Pergamon Press, 1958. Pp. xviii + 402. 90*s*.

The appearance in English of this well-known text has been awaited for some time, and those who might anticipate using the text as a teaching reference book will not be disappointed. It should, however, be borne in mind that the original text was published for the use of a non-English-speaking public and that the English translation, therefore, suffers in that much material is included which has already been adequately covered in other texts. The book is divided into three parts: Part 1, The Thermodynamics of Solutions of Non-electrolytes, in which the most important section is Chapter Four, dealing with vapour–liquid equilibrium in real systems; Part 2, Laboratory Technique, which, in addition to dealing with purity, temperature measurements, and pressure measurements, gives a complete review of all methods by which vapour pressure and vapour–liquid equilibrium may be determined; and Part 3, Tabulated Vapour–Liquid Equilibrium Data.

The treatment of vapour–liquid equilibrium in real systems contains a good deal that is new, and the presentation is excellent. Workers in this field will find of considerable value the appendix to this section, which lists the values of the functions $\frac{1-x}{x}$ and $\frac{x}{1-x}$ for all values of x.

The descriptions of laboratory apparatus used for the determination of vapour pressure is good and each apparatus is illustrated clearly by excellent drawings. If there is a criticism of this section it is that the various equilibrium stills are described somewhat uncritically. Some comments on the difficulties of operation and disadvantages of certain of these units would be of great value to students.

In Part 3 references are given to published data up to 1957 on vapour–liquid equilibrium listed alphabetically according to the constituents of the systems. This is followed by an author index of more than 1200 original publications. In view of the large amount of data published in this field, it is understandable that the authors decided not to list the actual data nor to make any critical assessment of the reliability and consistency of the published data.

The work is well-produced with clear illustrations and adequately referenced. It will be of great value to students and research workers, both as a reference book and a teaching text. F. M.

Handbook of Automation, Computation, and Control. Vol. 1. Control Fundamentals. Ed. Eugene Grabbe, Simon Ramo, and Dean E. Wooldridge. New York: John Wiley and Sons; London: Chapman and Hall. Pp. xx +994. 136*s*.

This is the first of three volumes which will constitute the Handbook of Automation, Computation, and Control.

Volumes 2 and 3, which have not yet appeared, will deal respectively with computers and data processing, and with systems and components.

Volume 1 is divided into five sections, namely: General Mathematics (213 pp.), Numerical Analysis (90 pp.), Operations Research (129 pp.), Information Theory and Transmission (114 pp.), and Feedback Control (426 pp.), followed by a 20-page index. The purpose of the handbook is explicitly stated in the preface to be to gather together in one place the available theory and information on these five topics with the emphasis on practical methods of applying the theory and new techniques, and on the ever-broadening role of the electronic computer.

In his foreword, Gordon S. Brown, of the Massachusetts Institute of Technology, claims that the handbook " truly represents today's optimum package of that body of knowledge that will be negotiable at par by technologists for many years to come in a wide range of disciplines." In actual fact, Volume 1 is a remarkably good book; but it should be made clear that the presentation is highly mathematical and as such is unlikely to be helpful except to the specialist who already has a rather thorough grounding in mathematics to graduate level. It seems unlikely that all those problem-solvers—engineers, scientists, technicians, and managers—at whom the book is said to be directed, will have had so mathematical a background.

Apart from considerations of content, one of the most formidable tasks in the preparation of such a handbook lies in preserving balance and avoiding duplication between independent contributors. Within the sections of Volume 1 this difficulty has been largely avoided through the choice of authors of a common allegiance; for example, the largest section of the book, on feedback control, represents a combined effort of ten authors, all of whom are members of the staff of the General Electric Company, albeit in different locations; similarly, the opening section on general mathematics is contributed by seven different authors, all from the University of Michigan, Ann Arbor.

Not unnaturally, therefore, the method of presentation of the mathematics reflects the modern style of teaching which is practised at Ann Arbor and, by way of caution, it should be stated that this will probably be unfamiliar to those whose mathematics started with Euclid. To look up a point on probability (Chapter 12), for example, one will find oneself plunged into Boolean algebra (Chapter 11), which in turn refers one to sets and relations (Chapter 1). This may savour somewhat of snakes and ladders, but is rewarding if one perseveres and is the price that has to be paid for the evolution of teaching.

More relevant criticism might be levelled at the chapter on statistics, which is quite inadequate both in content and bibliography in relation to the subject matter as a whole. Tables of the normal integral and of the chi-squared distribution are out of place, whereas, to quote but two major omissions, neither multi-variate nor time-series analysis gets so much as a mention.

In contrast to the statistical content, the section on operations research contains altogether too much detail for a book of this character. This is not the right vehicle for a ten-page description of the transportation problem and its solution; a single page devoted to the formulation of the problem with references to the literature would have been ample. Equally it is unnecessary to spend two pages on Newton's method of finding a root to an algebraic equation when this has already been adequately described in six lines of Chapter 2. Incidentally, the bibliography of this section contains more than three times as many statistical references as that of the chapter devoted to statistics.

These and others are relatively minor criticisms, however, when weighed against the admirable quality of the work as a whole. The typography and the setting of the mathematical content are both excellent, and specialists in this and related fields of activity are advised to acquire more detailed knowledge of the contents than can be gleaned from a brief general review. G. W. S.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren " Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the " Library Catalogue " published by the Institute.

000 Ludecke, C. *and* Ivanovzsky, L. *editors*. Taschenbuch für die Wachsindustrie. Stuttgart, Wissenschaftliche Verlagsgesellschaft, 1958. 718 p.

020 The British Council. Annual report 1957–58. London, British Council, 1958. 111 p.

030 Department of Scientific and Industrial Research. *Fuel research board*. Fuel research 1957. London, H.M.S.O., 1958. 59 p.

050 Bray, A. *editor*. Russian–English scientific technical dictionary. London, Allen and Unwin, 1945. 551 p.

080 Who's Who in the Gas Industry, 1959. London, Arrow Press, 1958. 229 p.

090 American Petroleum Institute. API recommended practice for testing oil-well cements. 7th edition. New York, API, 1958. 34 p. (RP 10B.)

090 American Petroleum Institute. API specification for small welded production tanks. 4th edition. New York, API, 1957. 12 p. (STD 12F.)

090 American Petroleum Institute. Standard for field welding of pipelines. 5th edition. New York, API, 1958. 26 p. (STD 1104.)

090 British Standards Institution. Architects', engineers' and surveyors' scales. Part 2: plastic scales. London, BSI, 1959. 22 p. (BS 1347: Part 2: 1959.)

090 British Standards Institution. Cast and forged steel valves . . . for the petroleum industry. London, BSI, 1958. 19 p. (BS 2995 : 1958.)

090 British Standards Institution. Dimensions of ball bearings and parallel-roller bearings. London, BSI, 1958. 65 p. (BS 292 : 1958.)

090 British Standards Institution. Dimensions of gaskets for pipe flanges. London, BSI, 1959. 23 p. (BS 3063 : 1959.)

090 BRITISH STANDARDS INSTITUTION. Electric lifts. Part 1: general requirements. London, BSI, 1958. 55 p. (BS 2655: Part 1: 1958.)

090 BRITISH STANDARDS INSTITUTION. Engineers' cold chisels. London, BSI, 1959. 19 p. (BS 2066: 1959.)

090 BRITISH STANDARDS INSTITUTION. Fusion welded pressure vessels for use in the chemical, petroleum, and allied industries. Part 1: Carbon and low alloy steels. London, BSI. 1958. 133 p. (BS 1500: 1958.)

090 BRITISH STANDARDS INSTITUTION. Higher tensile steel "C" hooks. London, BSI, 1958. 36 p. (BS 3033 : 1958.)

090 BRITISH STANDARDS INSTITUTION. Higher tensile steel shackles. London, BSI, 1958. 35 p. (BS 3032 : 1958.)

220 DESTY, D. H. *editor*. Gas chromatography 1958: proceedings of the second symposium organized . . . under the auspices of the Hydrocarbon research group of the Institute of Petroleum . . . 19–23 May 1958. London, Butterworth, 1958. 383 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

691. Practical petrographic classification of limestones. R. L. Folk. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (1), 1–38.—Limestones are divisible into 11 basic types, which are relatively easy to recognize both in the lab and in the field. These rocks are made up of three constituents: (1) allochems, evidently transported or otherwise differentiated carbonate bodies; (2) 1–4-μ microcrystalline calcite ooze matrix; and (3) coarser and clearer sparry calcite, which in most rocks forms as a simple pore-filling cement (like the calcite cement in a quartz sandstone), and only uncommonly forms by recrystallization. Only four types of allochems are volumetrically important in limestones: (*a*) intraclasts (reworked fragments of penecontemporaneous carbonate sediment); (*b*) oolites; (*c*) fossils; and (*d*) pellets (rounded aggregates of microcrystalline calcite averaging 0·04–0·10 mm). Allochems provide the structural framework of limestones, just as sand grains provide the structural framework of sandstones; microcrystalline calcite and sparry calcite are analogous with the clay matrix and chemical cement of sandstones.

A triangular diagram showing the relative proportions of allochems, calcite ooze matrix, and sparry calcite cement is used to define three major limestone families. Family I consists of abundant allochems cemented by sparry calcite; these are the cleanly washed limestones, analogous with well-sorted, clay-free sandstones and similarly formed in loci of vigorous currents. Family II consists of variable amounts of allochems embedded in a microcrystalline ooze matrix; these are the poorly washed limestones that are analogous with clayey, poorly sorted sandstones, and form in loci of ineffective currents. Family III limestones consist almost entirely of calcite ooze, hence are analogous with terrigenous claystones. E. N. T.

692. Curtain time for SW. Texas play. F. J. Gardner. *Oil Gas J.*, 19.1.59, **57** (3), 159.—There is expected to be active exploration during 1959 in the area of SW. Texas between the Delaware basin in the W. and the Edwards arch on the E. Little is known of the subsurface geology of this area, but it contains the world's deepest well which was drilled in Pecos County in 1958 to a depth of 25,340 ft. Several gas fields have been found in the area, one of the most important being Pluckett, also in Pecos County, where Devonian and Ordovi-

cian pays between 10,000 and 15,000 ft were found in 1952. Shallow oil has been found in the NE. part of the area, but only gas in the W. C. A. F.

693. Salt domes: favourite home for oil. M. A. Hanna. *Oil Gas J.*, 2.2.59, **57** (6), 138.—278 salt domes and structures have been found productive along the coast of the Gulf of Mexico, and 17 of these along the Texas coast had each produced over 50 million brl by the end of 1956. The origin and distribution of salt domes is discussed, and it is claimed that the parent material was a salt layer known as the Louann salt, and that some form of "trigger action" started the movement. It is possible that this was due to faulting and folding of beds causing a static load differential in beds later deposited above the salt. It is concluded that some domes on the continental shelf are rising at a rate of one ft in 100 years. The cap rock, often an important reservoir rock, is probably due to solution of the growing dome by artesian waters, and similar action is thought to be the cause of dome overhangs. A variety of structural and stratigraphic traps are associated with these domes, and diagrams show the mechanism of dome growth and possible traps. C. A. F.

694. Stratigraphic traps along North shelf of Anadarko basin, Oklahoma. J. D. Pate. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (1), 39–59.—Extensive stratigraphic accumulations of oil and gas along the N. shelf of the Anadarko basin have been the visions of petroleum geologists for more than two decades; however, only recently have these visions become a reality. Discoveries of important oil and gas reserves in the Laverne, SE. Stockholm, Woodward, and the "Cherokee trend" fields have focused the attention of all exploration men on the stratigraphic trap possibilities of the N. shelf area.

Early exploration along the shelf consisted of surface mapping, core drilling, and geophysical surveying. Test wells, drilled without the aid of gas detectors and modern methods of surveying the borehole, penetrated many gas reservoirs which were unrecognized and therefore not evaluated.

Many stratigraphic trap possibilities in most of the Palæozoic sediments, ranging in age from Silurian–Devonian into Early Permian, can now be recognized through the information obtained from the numerous deep tests which have been drilled along the shelf area and in the basin proper.

E. N. T.

695. Relations of Lower Cretaceous and Upper Jurassic rocks, Four Corners area, Colorado. E. B. Ekren and F. N. Houser. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (1), 190–201.—In many parts of the Colorado Plateau continuous conglomerate and sandstone lenses within the Burro Canyon formation (Early Cretaceous age) present a contrast to the dominantly mudstone upper part of the Morrison formation (Late Jurassic age). In the Four Corners area of SW. Colorado, however, the lithologic character of the Burro Canyon is extremely variable, and in places the formation consists entirely of mudstone.

The mudstone of the Burro Canyon formation and mudstone of the Brushy basin member of the Morrison formation characteristically weather differently, the mudstone of the Burro Canyon to hackly fragments and mudstone of the Brushy basin member to a hard frothy crust. This difference is believed due to original differences in composition rather than diagenetic processes, and it was found to persist throughout SW. Colorado.

The compensatory thickening of the Burro Canyon formation in relation to the Morrison formation, lateral change within short distances from mudstone of the Burro Canyon to mudstone of the Brushy basin member, lack of evidence of a persistent unconformity between the Morrison and Burro Canyon, and the partial interbedding and intertonguing of the lowest conglomerate and sandstone of the Burro Canyon with mudstone of the Brushy basin indicate that the Burro Canyon formation and Brushy basin member of the Morrison formation are conformable and intertongue. The lack of fossil evidence prohibits precise placement of the Jurassic–Cretaceous time boundary. E. N. T.

696. The Mesaverde—new target in the Denver basin. C. J. Nolte. *Oil Gas J.*, 19.1.59, **57** (3), 160.—Oil possibilities of the Upper Cretaceous Mesaverde in the Denver basin of Wyoming and Colorado are evaluated, and it is claimed that the formation has never been adequately tested, although to date some 2300 wells have been drilled through the Mesaverde on the E. flank of the basin without finding commercial production. The Mesaverde sands are associated with petroliferous Pierre shale, and they are potential reservoir sands. Possible traps are local closures, fault traps, regional stratigraphic traps, and local sand bars. Economics favour exploration of the Mesaverde; it is topped at relatively shallow depths, between *ca* 2800 and 5000 ft, and a full test costs approx $10,000. The area is accessible, has a ready market, and no proration. Examples of logs of the Mesaverde are given. 2 refs. C. A. F.

697. Lower Palæozoic rocks of Northern Williston basin and adjacent areas. J. W. Porter and J. G. C. M. Fuller. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (1), 124–89.—Between 1952 and 1957 the sudden and systematic development of Mississippian and younger oilfields in the general area of the N. Williston basin, proceeding concurrently with diligent use of palæogeological and palæogeographical studies, greatly expanded and improved existing conceptions of the geology. Much of the knowledge thus gained, particularly of the depositional regime imposed in the Williston arena during Upper Palæozoic time, is readily applicable to a study of the Lower Palæozoic deposits. In view of this, the importance of the recent discoveries of producible quantities of oil in the Ordovician and Silurian rocks underlying the international border area of Saskatchewan, N. North Dakota, and E. Montana, will be appreciated quickly.

The writers aim to make a connected statement, at an early stage of exploitation, of the geology and petroleum prospects of the Lower Palæozoic rocks, particularly the carbonate rocks, beneath the NE. part of the Plains. The conclusions are based on a study of subsurface data obtained from more than 450 boreholes. E. N. T.

698. Southern Michigan wildcatters play it by ear. F. J. Gardner. *Oil Gas J.*, 2.2.59, **57** (6), 137.—There is active interest in the oil possibilities of S. Michigan between Detroit and Chicago where there have been two recent finds along a 12-mile trend. A wildcat *ca* 12 miles NW. of the Scipio field was completed in Dec 1958 for 296 bd from Trenton–Black River dolomite at 4090 ft and another test *ca* 6 miles NW. of Scipio found oil in the same pay. Production in the area apparently depends on dolomitization, the pay consisting of a secondary dolomite which is tightly folded and fractured. Structure has little influence on the accumulations.

There are now 25 Trenton producing wells in the Scipio field, where dry wells are structurally higher than the producers. C. A. F.

699. Pierre shale along Western and Northern flanks of Black Hills, Wyoming and Montana. C. S. Robinson *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (1), 101–23.—The marine Pierre shale, of Late Cretaceous age, on the N. and W. flanks of the Black Hills, consists of dark grey shale with some sandy shale and sandstone and many beds of bentonite. It ranges in thickness from 2000 to 2700 ft.

In this area the Pierre shale may be divided into several members on the basis of lithologic differences in the shale and the presence of sandy and bentonitic units. In ascending order these are the Gammon ferruginous member (including

the Groat sandstone bed), the Mitten black shale member, and an unnamed upper part that consists of half or more of the formation. This upper part is chiefly dark grey shale, but contains at the base a grey, silty shale unit, and near the top the Monument Hill and Kara bentonitic members.

Studies in progress reveal at least 16 ammonite zones in the Pierre shale on the W. flank of the Black Hills. E. N. T.

700. Mississippian stratigraphy and petroleum possibilities of Central Cape Breton Island, Nova Scotia. D. G. Kelley. *Canad. Min. metall. Bull.*, 1958, **51**, 341–51.—A study of the stratigraphy and sedimentation of Mississippian rocks in Central Cape Breton Island, with particular emphasis on regional correlation, facies change, and palæogeology, is presented. Early Mississippian deposition resulted in accumulation of >10,000 ft of gravel, sand, and silt in the W. part of the Whycocomagh map area along the present Gulf of St Lawrence shore-line. No Early Mississippian deposition took place approx 12 miles to SE. in the N. mountain area. Late Mississippian deposition was more widespread than that of Early Mississippian. Gradual sea transgression spread over the area, depositing sediments in the form of siltstone, shale, sandstone, limestone, gypsum, anhydrite, and salt in the central part of the basin. Pre-Cambrian and all Palæozoic periods excepting Permian are represented in the sedimentary and volcanic rocks of Central Cape Breton Island. Mississippian sedimentary rocks of Canada's Atlantic provinces are divisible into three groups: Lower Mississippian Horton, Upper Mississippian Windsor, and the Canso. The Mississippian section of Cape Breton Island is both a conformable and unconformable succession of strata. Drilling has taken place from 1864, chiefly near Lake Ainslie, up to 1914, and petroleum traces have been discovered in the vicinity in three localities. Known Windsor strata are probably not very favourable source rocks for petroleum. Horton strata—reservoir rocks for Stony Creek oil and gas field in New Brunswick—are favoured as the source of petroleum. The most promising structures which may have trapped petroleum are the anticlines in Horton underlying the highly-folded and faulted Windsor strata. Stratigraphical, sedimentological, and geophysical data do not recommend E. Cape Breton for petroleum exploration. 36 refs. R. T.

701. Cordilleran tectonics in British Columbia. W. H. White. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (1), 60–100.—The complicated structure of British Columbia is the cumulative result of no less than six major orogenies since the Proterozoic. Using local names to avoid unintended identification with orogenies elsewhere, these are: (1) East Kootenay, pre-Lower Cambrian; (2) Cariboo, post-Ordovician—pre-Mississippian; (3) Cassiar, post-Upper Permian—pre-Upper Triassic; (4) Coast Range, continuing from pre-Middle Jurassic to post-Lower Cretaceous and perhaps later; (5) Rocky Mountain, Palæocene; and finally (6) Puget orogeny, extending into modern time.

The effects of East Kootenay orogeny are preserved in Purcell strata that were greatly uplifted and mildly folded. The effects of the succeeding Cariboo orogeny are much more widespread. Eugeosynclinal strata of Proterozoic and Lower Palæozoic age from the 49th Parallel to Alaska were intensely folded, regionally metamorphosed, and extensively granitized. Later deformations have not obliterated but only modified these ancient structures. Folding, faulting, and widespread ultramafic intrusion occurred during the Cassiar orogeny.

A complicated sequence of folding, regional faulting, syntectonic sedimentation, and profound granitic intrusion marked Coast Range orogeny. As time went on Coast Range tectonism migrated eastward, merging insensibly into Rocky Mountain orogeny that culminated in Palæocene time. Profound crustal shortening was accomplished in the Rocky Mountain region by folding and thrust faulting.

Puget orogeny includes intermittent crustal disturbances that have continued into historic time. E. N. T.

702. Oil prospects in the Bahamas. H. Wassall and H. Dalton. *World Oil*, Feb 1959, **148** (2), 85.—Oil prospects in the Bahamas are similar to those in S. Florida and N. Cuba. The section consists of evaporites and marine limestones which are dolomitized and contain oil traces. (Similar limestones are productive in the Sunniland field in Florida.) Carbonaceous content is high and there are zones of good secondary porosity. Although only one test has been made in the islands, it is thought that the area is underlain by over 15,000 ft of sediments, the most important being the Palæocene, Cretaceous, and Jurassic. The test was drilled on Andros Island in 1945 and was bottomed at 14,585 ft in Lower Cretaceous. In 1958 a well was being drilled on Cay Sal Bank, 131 miles S. of Miami, but no information is available. Structures in the area are probably similar to those in Florida and Cuba, varying from strong, simple folds in the S. to gentle folds in the N. near Florida. Salt domes may also occur as in Cuba. In the NE. Bahamas there may be updip changes in lithology, providing stratigraphic traps. Details of wildcats and discoveries in S. Florida are given, and a concession map of the area is included. C. A. F.

703. Deep seismic results mean new exploration in Israel. H. I. Harris. *World Oil*, Feb 1959, **148** (2), 106.—Only one small oilfield has been found in Israel in spite of several years of intensive exploration and drilling, and this lack of success may be due to shallow unconformities masking deep structures. Recent geophysical work with improved techniques has, however, enabled deep seismic mapping to be carried out, and further exploration has been encouraged with the discovery of deep-seated anticlines. Refraction work has been particularly successful, using charges up to 500 lb, and deep faulting has been proved. Reflection work has also been used. Results of these methods have shown that Cenomanian structures are masked by post-Cenomanian beds in the coastal plain, so that the area can now be revaluated for its oil prospects. C. A. F.

DRILLING

704. Recent developments in drilling equipment. L. C. Uren. *World Petrol.*, Feb 1959, **30** (2), 55.—The oil industry in the U.S.A. spent $1175 million in 1957 for producing and drilling equipment; this is 7·3% higher than in 1955 and 18% higher than in 1954. During the last ten years there have been important changes in drilling methods, involving in many cases higher costs due to increased labour and equipment costs, as a result of increased drilling depths; different methods of making hole and removing cuttings; and new logging, casing, and cementing methods such as the use of shaped charges, gun perforators, hydraulic fracturing, and multiple zone completions. Of particular interest are the developments in well logging. The SP, resistivity, and radioactivity logs can now be used quantitatively and interpretation methods are being continually improved. New logging methods include the acoustic and density logs. New drilling techniques include the use of air or gas in place of mud, particularly useful in hard-rock areas; the turbodrill, which has been successfully used in Russia; and the percussion-rotary drill, which combines percussive and rotary movements on the bit. Deep drilling has required refined drilling fluid control, oil-base fluids being increasingly used in these wells. C. A. F.

705. Water can be controlled in air and gas drilling. Pt 1. Laboratory equipment and techniques show promise for field application. W. F. Hower *et al.* *World Oil*, Feb 1959, **148** (2), 90.—The main problem in air and gas drilling is the economic control of water normally suppressed by mud. The

rate of water entry is important, *e.g.* weeping zones provide enough water to wet the cuttings but not to flush them out of the well. Surfactants have been satisfactory in "foaming out" the water in many wells, and various plugging agents have been used. Because none of these methods has been entirely successful, lab research has been carried out to develop materials and treating techniques to control all types of water production. Cores from many areas have been water saturated and treated with solutions to determine their plugging effect. These solutions must have reliable setting characteristics and form a stiff gel or hard solid. Wells have been drilled to test the materials, details of the procedures being given. One of the most important techniques is the placing of the sealing solution and the formation being treated should be properly isolated. C. A. F.

706. Turbodrill: a specialized tool—not a cure-all. W. B. Bleakley. *Oil Gas J.*, 2.2.59, **57** (6), 86–7.—Conclusions of an industry panel meeting in Tulsa are that the turbodrill with diamond bits can be used economically where: rotary rock bits make less than 75 ft before failure; rotary penetration rate is less than 10 ft/hr; rig cost greater than \$50/hr; hole dia less than 9 inches; formations are medium-hard to hard; and trip time is long. If rock bits are used with the turbodrill the equivalent conditions are: that penetration rates are low; hole size is large; formations are hard but not abrasive; and trip time is short. In either event rig hydraulics must be adequate. With normal rock bits bit footage has been *ca* 50–75% of that with same bits on a conventional rotary rig. Diamond bits have been more successful. A limited quantity of lost-circulation material may be used with the turbodrill, but the latter is not a good tool in lost circulation zones. J. C. M. T.

707. Five rigs do the work of six. R. F. Hill. *Drilling*, Jan 1959, **20** (3), 63–5.—An estimated 20% increase of equipment utilization has been obtained by a drilling contractor by the use of electronic inventory control. A punched-card system records details of cost, date bought, and whereabouts of every piece of equipment, and whether in use or not. This information is rapidly available when required, enabling equipment to be employed where most needed. Data on costs and maintenance facilitate choice of most suitable equipment when new purchases are necessary. J. C. M. T.

708. 6 or 8 lines: which hoisting system is better? B. G. Williams. *World Oil*, Feb 1959, **148** (2), 61.—The relative advantages of six and eight lines on the pulley system connecting the travelling block and crown block on the rotary derrick are described, and it is shown that the use of more lines reduces the load on the rig. In choosing the number of lines to be used the most important factors are the design stress of the wire line (the normal breaking strength divided by the safety factor) and the shock factor on the derrick. The efficiency of using six or eight lines can be determined from the formula:

$$\text{Efficiency} = \frac{C^n - 1}{nC^n(C - 1)}$$

where n = turns of the line on the sheave; C = constant, depending on line, sheave, and bearing dia, and coeff of friction. Thus the more lines used, the lower the efficiency. C. A. F.

709. Use of small diameter casing reduces well costs. M. H. Stekoll and W. L. Hodges. *World Oil*, Feb 1959, **148** (2), 70.—The results of the use of small dia casing for completing wells in the Mid-Continent of the U.S.A. during the past 15 years are described. Completion costs have been appreciably reduced; a typical 5000-ft well fitted with 2⅞-inch casing costs \$7500–8500 less than one with 5½-inch casing, which provides enough money to drill an additional 1 in 7 wells. 1-inch tubing is used in these wells, replacing conventional rod and tubing strings.

Case histories of completed wells are given, and it is claimed that using modern equipment it is possible to carry out almost all workover jobs in small dia pipe. Dual completions are possible with 2⅛-inch pipe by cementing two separate strings of casing in the hole. Tables showing comparative costs are included. C. A. F.

710. Detecting presence of oil in hole. Anon. *World Oil*, Jan 1959, **148** (1), 181.—The early development of rotary drilling was retarded by difficulties in detecting oil or gas formations, although the method was more efficient for drilling than the cable tool system. Developments since the 1920s have, however, largely overcome this problem, the first important step being the introduction of improved rotary core barrels and coring techniques in the early 1920s. Later important developments include drill-stem testing and electric logging. Each of these methods has been further improved in recent years, and reliable data on oil, gas, and water content of formations can now be obtained. There have also been advances in methods of analysing mud returns, and many wells are now completed in formations which would formerly have been overlooked. C. A. F.

711. Radioactivity logs for gas location. D. H. McLendon. *World Oil*, Feb 1959, **148** (2), 79.—The radioactivity log is at present the best log available for detecting gas-bearing formations. The neutron log is the most useful for this purpose, and two types are available, the neutron–gamma and the neutron–neutron. In the first type the formations are bombarded with neutrons and fast γ-rays are detected, and in the second slow neutrons are detected. Both are interpreted in the same way and give a record of hydrogen content. A recently developed technique enables LPG levels in underground cavities to be determined. A radium source is used on a sonde which emits γ-rays, and these are scattered by an amount which is a function of the density of the surrounding material. As brine is denser than LPG, the density interface marking the LPG/brine level can be observed by a change in γ-ray intensity on the detector. Examples of the use of radioactive logs in gas wells are given and described. 4 refs. C. A. F.

712. Effective porosity and water saturation from electric and microlog data. E. T. Guerro and F. M. Stewart. *Oil Gas J.*, 9.2.59, **57** (7), 108–10.—Nomographs are provided for the solution of the four equations needed to determine effective porosity and water saturation from electric and microlog data. Additional data needed are SP readings opposite thick shale and thick, clean sand beds, and an estimate of mud filtrate saturation adjacent to borehole from flood-pot tests. J. C. M. T.

713. What's new in mud-logging techniques. J. G. Caran and S. H. Caran. *Oil Gas J.*, 9.2.59, **57** (7), 116–20.—Deeper exploratory drilling has produced a need for better ways of measuring and identifying hydrocarbon gases in mud stream and cuttings than were provided by fluorescent techniques and the hot-wire detector. Mass spectrometry and i.r. analysers have been tried, but the former suffers from the disadvantage of complexity and need for skilled operators, and the latter from need for a separate analyser for each component to be detected. Newest tool is the gas chromatograph. This is suitable for complete analyses for every 2 ft of penetration, with possible sensitivity of 10 ppm, and the instrumentation is simple and reliable. J. C. M. T.

714. Analysing mud solids saves time and money. P. W. Cooke. *World Oil*, Feb 1959, **148** (2), 66.—Visc problems in weighted muds are due to contamination (such as cement and salt), chemical deficiency, or to excess clay particles in suspension. A knowledge of total mud solids is therefore necessary

to maintain proper mud visc, and a method of lab analysis is given. A small increase in clay content can increase visc appreciably so that the determination of total solids should be accurate. Procedures for fresh water mud (no oil present) and fresh water/oil emulsion mud are described. In each case a known vol of mud is heated to constant weight and reweighed, and calc of clay content is based on tables provided. Additional charts show: (1) specific gravity of dried solids *v.* % clay by vol on total solids; (2) clay solids content of mud *v.* mud weight; and (3) mud weight and clay solid content by vol on mud for various contents of water base. C. A. F.

PRODUCTION

715. Production operations. Anon. *World Oil*, Jan 1959, **148** (1), 191.—Developments in production methods during the history of the oil industry are described, and it is shown that the concept of producing oil with the minimum of associated gas and water has led to many complex technical operations. In the U.S.A., unitization, first introduced in the 1920s, has led to efficient production methods, enabling pressure maintenance and secondary methods to be efficiently applied. Reservoir models have been useful for this purpose. Well equipment has been continuously improved, the introduction of tubing, flow beans, and separators being important in lowering costs by reducing gas/oil ratios and assisting conservation. Pumping methods initially used simple jacks and rods, but it is now possible to pump hydraulically. Gas lift has similarly been improved, and it can now be applied to dual completion and to wells permanently completed. There has been outstanding progress in well stimulation in recent years, and developments include the use of shaped charges and formation fracturing. The growth of U.S. secondary recovery operations is described, together with the progress in well workover techniques, oil–water emulsion treatment, and salt water disposal methods. C. A. F.

716. Foaming agents are low-cost treatment for tired gassers. H. N. Dunning and J. L. Eakin. *Oil Gas J.*, 2.2.59, **57** (6), 108–10.—Lab experiments and field tests suggest an inexpensive method of removing water from "drowned" gas wells, without costly workover equipment. Foaming agents introduced into the water column enable gradual lifting of the water in the form of a light foam by gas pressures too low to lift the water column itself. Most promising cpds are non-ionic polyoxyethylated alkylphenols and non-ionic polyoxyethylated detergents. Enough cpd is pumped or lubricated into the well to give at least 0·2% soln with the water in the well. The cpd should be thinned with solvent, *e.g.* alcohol, for easy handling and emplacement. The cpd must be mixed with the water in the well, and if there is no tubing or siphon the well should be shut-in for *ca* 1 hr after introduction to ensure this. Four case histories are described. The method has been successful in producing zones from 650 to 3400 ft deep with well-head pressure as low as 20 psi. Scale, mud, sand, and heavy oils are also removed by this treatment. The effect is temporary, but continuous treatment is feasible. J. C. M. T.

717. Miscible-phase floods may precipitate asphalt. R. B. Bossler and P. B. Crawford. *Oil Gas J.*, 23.2.59, **57** (9), 137–45.—Addition of light hydrocarbons to crude oil causes the separation of asphalt, wax, or other heavy fractions. The quantities precipitated are in an inverse ratio to the mol wt of the solvent. These colloidal and solubility phenomena are discussed in relation to the effects of temp and pressure. It is concluded that in miscible-displacement methods of secondary recovery asphalt or heavy hydrocarbons are likely to be precipitated where the injected LPG mixes with the crude oil, leading to local clogging of the sand. Failure of one miscible-displacement field trial is attributed to this cause. J. C. M. T.

718. Water flooding in the Lendava oilfield. L. Berdon. *Nafta* (*Yugoslavia*), 1958, **9** (12), 357–65.—In the article is described a proposition for secondary oil recovery by water flooding in the Lendava oilfield, namely, a "pilot" flooding for an upper oil horizon, Ratka. A water conditioning plan is also treated in the test. (Author's abstract.)

719. Needed: wider well spacing. R. M. Williams. *World Oil*, Feb 1959, **148** (2), 98.—Unnecessary drilling in the U.S.A. results in excessive costs, and although close well spacing may give a higher current rate of production, ultimate recovery may not be significantly increased. Excess wells can also damage the landowner's surface and increase the risk of unsatisfactory completions and inefficient wells. A solution to the problem is proposed in three stages: (1) an initial spacing, the widest possible, is established on development; (2) optimum spacing is determined after enough wells have been drilled and appropriate data are available; and (3) the regulatory agency permits infill drilling and closer spacing if more wells are required due to revaluation or the need for increasing production rate. C. A. F.

720. Completion methods. Anon. *World Oil*, Jan 1959, **148** (1), 185.—The development of completion methods during the history of the oil industry is described. An important factor was the introduction of strong casing and the use of floating equipment, enabling deep strings to be run. Improved cementing techniques with the aid of wall scratchers and caliper logging have given efficient wall seals. Many special cements are now available for solving particular problems. Early wells were completed in open hole, but problems of sand production led to the development of sand exclusion techniques using screens and gravel packs. Later, thermosetting plastics were used for this purpose. Gun perforating has made possible the testing of multiple zones in a well, and there have been recent improvements in bullet penetration. Dual completion led to multi-zone completions, the first quadruple completion being made in 1958. Permanent type completions, with remedial and recompletion work being carried out through the tubing with wire-line tools, have proved very successful. C. A. F.

721. Material balance equations for gas reservoirs with water drive. J. R. Fraser and A. E. Campbell. *World Oil*, Feb 1959, **148** (2), 63.—The application of the material balance equation, together with a water influx equation in computing gas reserves, is described. Using the Schilthius water influx equation, it is shown that the equation becomes (using conventional symbols):

$$C\int_0^t \Delta P\, dt - wt = V_o\left(1 - \frac{P_o Z_t}{P_t Z_o}\right) + \frac{0{\cdot}0282\ T_r Z_t Q_t}{P_t}$$

Details of the derivation of the quantities are given, and it is shown that the equation requires only the minimum of data. An example from a W. Texas condensate reservoir is given. 9 refs. C. A. F.

722. Inhibitor squeeze treatment is promising. W. B. Bleakley. *Oil Gas J.*, 9.2.59, **57** (7), 114–15.—Corrosion-inhibiting cpds pumped into a producing formation from the well are adsorbed on the reservoir rock and only slowly released during subsequent production. This slow release into the produced fluids protects the well from corrosion for 3–6 months. Oil- or water-soluble cpds are used according to reservoir characteristics, in quantities up to 10 brl/treatment. Method has been used on all types of wells with success in 90% of cases. Efficiency of treatment can be determined by iron content of produced fluids. J. C. M. T.

OILFIELD DEVELOPMENT

723. World crude production tops 18 million barrels daily. Anon. *World Petrol.*, Jan 1959, **30** (1), 32.—World oil production in 1958 was 18,098,900 bd, 2·4% higher than in 1957. Output of natural gas liq was 1 million bd, as in the previous year. 1958 saw a slower rate of rise in production due to several economic factors, including a disappointing level in products sale in the U.S.A. World consumption of oil increased by *ca* 6% during 1958 to 18,930,000 bd, but in the W. Hemisphere the rise was only 2·6%, due mainly to the recession. A sharp improvement in American markets is expected during 1959. World demand should increase to approx 20,232,000 bd in the current year. Middle East output rose in 1958, following the restriction during the Suez campaign. C. A. F.

724. Canada expects 10% rise in 1959 domestic crude production. L. O. Rowland. *World Petrol.*, Jan 1959, **30** (1), 53.—Crude production in Canada in 1958 declined by approx 10·5% to 163 million brl, but it is expected to rise to approx 500,000 bd in 1959, comparable with the 1957 level. The decline was due to loss of Pacific Coast markets, felt chiefly in Alberta, where output last year fell by approx 20%. A further reduction in exports in 1959 is probable, but a substantial increase in domestic demand is likely.

2550 wells were completed in Canada in 1958, 14% less than in 1957, but there was a moderate increase in Alberta, activity in Saskatchewan being at a lower level. A trend to wider spacing continues, 160-acre becoming increasingly used, and 80-acre a minimum in most fields. Geophysical activity substantially decreased in 1958, and most of the work continued to be seismic.

Gas production in 1958 was at a record level, being approx 25% higher than in 1957, at approx 400 billion cu ft. Pipeline construction continued at a high level last year, and further expansion is expected in 1959. Refinery runs were reduced in 1958 due to heavy overstocks at the beginning of the year. C. A. F.

725. Paris basin strike sets pace. Anon. *Oil Gas J.*, 26.1.59, **57** (4), 117.—A wildcat in the Aube district of France, SE. of Paris, has been brought in at rate of 75 bd from 6780 ft. The Coulommes field discovered last year now has 13 wells and is expected to produce 2000 bd in 1959. Small production is also now obtained at Chateaurenard. Development drilling is under way at Chaillis-en-Biere, and good shows have been encountered in a wildcat at Crouy-sur-Qurcq. These 1958–59 discoveries in the Paris basin are ranked in importance with the discovery of the Parentis field five years ago. J. C. M. T.

726. More companies in international oil. Anon. *Petrol. Press Serv.*, 1958, **25**, 297–300.—The demarcation line between major international oil groups and companies operating in a more restricted sphere—previously well-defined—is becoming indistinct. Many oil companies are entering into exploration or production outside the countries in which they are domiciled. This applies particularly, but not exclusively, to American oil undertakings. Increasing difficulty of finding adequate oil reserves in the U.S.A., and the high cost level ruling there, have impelled many to seek better prospects elsewhere (*Petrol. Press Serv.*, May 1958, 190). U.S. companies have extended their holdings in Latin America and Canada, as well as embarking on ventures in Europe, the Middle East, N. Africa, and Asia. Some European companies have also been pushing into new regions. Information is presented on the activities of American and European oil undertakings at home and abroad. Information is given on exploration in Somalia by Sinclair Oil Corpn and Conorada in *Petrol. Press. Serv.*, April 1958, 145; in Canada, Venezuela, Cuba, and the Persian Gulf by Standard Oil Co. (Indiana) in *Petrol. Press Serv.*, June 1958, 221; in Guatemala, Paraguay, Turkey, and Pakistan by Tidewater Oil Co. in *Petrol. Press Serv.*, May 1958, 194. The scale of operations of many companies is given in a table, which may be compared with tables in the article on the major international companies in the June issue, p. 209. The bulk of production and earnings of these smaller companies comes from operations in the U.S.A. The companies have few marketing interests elsewhere, and only a small vol of foreign production, which is increasing. R. T.

TRANSPORT AND STORAGE

727. The world tanker fleet. Anon. *Petrol. Times*, 13.3.59, **63** (1607), 169.—Extracts are given from the annual review of John I. Jacobs & Co. Ltd, and deal with flag changes, new building and their ownership, size, speed, and mode of propulsion, and future outlook.

Total new building tonnage under construction or on order at the end of 1958 was 716 vessels of an aggregate of 25,632,200 dw tons. British flag total of 5,620,000 dw tons represents 65% of the present fleet. Three ships of 100,000 dw tons or over are to be constructed. 70% or more motor tankers are operating on high visc fuel, and the first atomic propelled surface vessel, the American *Savannah*, is progressing.

1958 was a depressing year, and a balanced position is not foreseen until 1963. A scheme similar to that operated in the 1930s has been adopted in principle to alleviate hardship. G. A. C.

728. World tanker statistics third quarter 1958. Anon. *Inst. Petrol. Rev.*, 1958, **12** (144), 396–7.—Oil tankers under construction in the world amounted to 366 ships of 5,522,289 gross tons during the third quarter of 1958 and accounted for 54·1% of the total world tonnage of merchant shipping. Details of the registration of oil tankers under construction at the end of Sept 1958 are tabulated. A. D. S.

729. Tanker heating coils. Anon and A. B. Everest. *Fluid Handl.*, Feb 1959, (109), 39–40.—Comment and correspondence on previous article (*cf.* Abs. **497**, 1959). W. A. M.

730. Arrival of mv *Methane Pioneer*. Anon. *Petrol. Times*, 27.2.59, **63** (1606), 130.—2000 tons of liq natural gas in five aluminium tanks of the *Methane Pioneer* out of the Gulf of Mexico arrived at Canvey Island on 20 Feb 1959 after a 23-day voyage. The vessel is of 5000 tons and is the first to make the trip, which marks the first stage of an experiment which proves liq methane can successfully be transported over long distances in specially designed tankers at a temp of −260°F. G. A. C.

731. The maiden voyage of the mv *Methane Pioneer*. Anon. *Petrol. Times*, 13.2.59, **63** (1605), 104.—A summary is given of the development of the vessel carrying the first tanker load of liq methane from the Gulf Coast to Canvey Island. The venture is the result of 20 years of discussion, research, and development, involving design of units for liquefication of natural gas and storage of the cold liq at its bp at atmosphere pressure. Sizes, shapes, and performance of the units, including storage tanks, and of metals used had to be taken into account. The *Methane Pioneer*, now carrying the product, was originally a dry cargo boat, the mv *Normate*. G. A. C.

732. North West oil pipeline. Anon. *Engineer, Lond.*, 1959, **207**, 356–8.—390-km, 28-inch Wilhelmshaven–Cologne line supplies six refineries and petrochem plants in Rhineland/Ruhr. Cost (inc planned extensions) is *ca* 3×10^8 DM; participating companies are listed. Ultimate capacity 2×10^7 tons p.a. Discharge pier at sea end is accessible to

100,000-ton tankers. Four pumping stations (100-km spacing), max pump pressure 70 atm; remote control from Wilhelmshaven. Constructional details and photographs.
V. B.

733. New process developed for double jointing pipe. B. Quarles. *Pipe Line News*, Jan 1959, **31** (1), 31–5.—Bechtel Corpn of California has developed a new process for double jointing pipe. The welding is by the submerged-arc process, all from the outside of the pipe, and provides a high quality weld and economical means of double jointing pipe in the field.

The outstanding feature of this process is a flexible Fiberglas sleeve held firmly under the welding groove by a line-up clamp. This " glass " sleeve conforms to the contours of the joint and allows the metal to solidify without cold lapse. Welds made by this process, it is claimed, consistently give 100% penetration and meet all code requirements.
M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

734. Use of refinery products by the gas industry. C. Johnson. *Petrol. Times*, 27.2.59, **63** (1606), 127.—Use of refinery gases to enrich low value coal gases is reviewed, and some gasification processes and plants are described. Both low- and high-pressure gasification processes are employed, and flow sheets of the Onia-Gegi and Segas plants are given, together with that for a high-pressure unit for heavy oil.

A unit not employing a cat has been developed by Royal Dutch/Shell, and it uses any hydrocarbon feedstocks from rich gas to heavy residual oil; capacity is 21 million cu ft/day.
G. A. C.

735. Control of marine organisms in a salt-water cooling system. D. H. Tullis, L. C. Neill, and A. T. Henderson. *Petrol. Times*, 27.2.59, **63** (1606), 142.—A summary is given of the paper with the above title presented at the IP, Feb 1959. Slime formation and marine micro-organisms cause fouling of heat exchangers, condensers, and cooling water circuit in the Coryton plant. Slime control is mostly controlled by a Wallace and Tiernan vacuum type chlorinator, but the original method proved inadequate for control of *Mytilus edulis*, the black edible mussel. Installed pump capacity was 37,500 gpm, using two 650-hp electric pumps and one turbine stand-by. Chlorine was at first injected at rate of 2½ lb/minute for 12 minutes every 4 hr, but as a result of investigations rate was changed to 50 minutes every 8 hr at same dosage. Seasonal and other changes were investigated and led to increasing chlorine injection during mussel breeding season May–Oct. Modifications made to plant now permit taking out of service any one line, static chlorinating it for 7–10 days, and then flushing out full bore.
G. A. C.

736. Russia's refining industry. D. Fraser. *Petrol. Times*, 27.2.59, **63** (1606), 139.—A review is given of Soviet refining industry, which has by 1957 expanded re total crude runs to more than four times the 1946 level. Refineries recently completed, those under construction, and projected refinery groups are discussed. Various modern techniques in refining are employed and a wide range of products obtained, some 218 different specifications applying. By 1965 crude output should be 230–240 million tons, and primary throughput capacity doubled. All the new refineries under construction are being linked by branch pipelines with regional oilfields. A map showing locations is given.
G. A. C.

ABSORPTION AND ADSORPTION

737. Field separation of liquids in oil and gas production. F. E. Cooper *et al.* *Oil Gas J.*, 9.2.59, **57** (7), 91.—The first article of this special section deals with how the various processes compare in payout, and shows that selection of the right processes from four depends on field conditions. The Dryex process, which employs a dry desiccant hydrocarbon recovery unit utilizing a closed regeneration system and operates under conditions where other types are not economical is next discussed, and then the supplementary of a low temp separator by a hydrogen recovery unit.

The development is described of an absorption refrigeration unit designed around oilfield components and controls, and finally a question and answer section is given.
G. A. C.

SOLVENT EXTRACTION AND DEWAXING

738. The dewaxing of lubricating oils with urea. (In Russian.) S. T. Kuz'min and N. I. Chernozhukov. *Khim. Tekh. Topliv i Masel*, Oct 1958, (10), 12–16.—Main factors influencing dewaxing with urea were the composition of the oily fraction, amounts of urea and activator, treatment temp, and contact time. For the production of low setting lub oils, recommended conditions were: amount of urea, 100% on charge; amount of activator, 9–10% on charge; dewaxing temp, 55° with gradual reduction to 25°; contact time, 30 minutes; amount of wash solvent, 50% on charge; amount of *iso*propyl alcohol, 100% on charge. The best activator was methanol.
G. W. T.

739. Urea inclusion compounds of straight-chain and branched aliphatic compounds. (In German.) E. Terres and S. Nath Sur. *BrennstChemie* 1957, **38** (21–22), 330–43.—Production and determination of quant relations of some urea and thiourea adducts as a basis for deparaffining mineral oil fractions are discussed. In adduct production a minimum of C-atoms must be present in the material to be added. Generally, the unbranched part of the chain must be longer the greater the space requirement and No. of substituents, and the further these are distant from the chain end. Thus, in case of a monomethyl substitution in the 2-, 3-, 4-, or 5-position in the straight C-chain, 11, 11, 15, and 16 atoms are necessary; in the 2,3- and 2,4-dimethyl substitution 17 or 18 C-atoms. No stoichiometric relation exists between urea and various added materials, but a linear function exists between quantity relations and No. of C-atoms in the chain. Equilibrium const of adduct formation for five homologous series, *n*-paraffins, *n*-olefins-1, *n*-alcohols-1, *n*-alkylbromides, and fatty acids were determined at 25°, 40°, and 50° C. A linear relation exists between quantity proportions and log K (dissociation const), also it is evident that the intersection point of log K = O-line with the 25° C-isotherm reproduces the M composition of the initial member of the homologous series qualified for urea adduct formation and that K-val decrease with increasing chain length. From this it appears that stability of the adduct rises with increasing chain length at lower temp more strongly than at higher temp. Measured heats of formation agree well with calc val. Heat of formation of the adducts is a linear function of the No. of C-atoms in the chain. Extensive tables and charts appear. 19 refs.
R. T.

CRACKING

740. Gasoline. Its processing and problems. L. Resen. *Oil Gas J.*, 16.2.59, **57** (8), 105.—A series of ten articles gives data on processing crude and splitting product streams to give the

most economic gasoline blends. Subjects include processing of reformates, splitting cat naphtha, superfractionation, removal of depressants, blending, isomerization of C_5 and C_6, and source of alkylation feedstock. G. A. C.

741. Investigation of inland natural catalysts for catalytic cracking of heavy gas oil distillates from inland crude oils. F. Sef and R. Lipovscak. *Nafta (Yugoslavia)*, 1958, **9** (12), 351–6.—The experimental equipment for the determination of the activity of powdered cat for fluid cat cracking is described. The method applied here is based on the test developed by the M. W. Kellogg Co. The decrease of the initial activity was tested by the repeated use of the same cat sample after its regeneration up to the content of *ca* 0·30% of carbon. For these tests standard light E. Texas gas oil and vacuum dist of inland crude oils were used. Samples of natural cat from Ljesljani and Ginovci prepared from inland montmorillonite clays were tested. The results obtained are here compared with the results obtained with the powdered Ketjen cat. The initial activity of inland natural cat is approx equal to the activity of the synthetic Ketjen cat usually applied in Yugoslav commercial plant. On the other hand, by using natural cat *ca* 20% less carbon is obtained for the same conversion. (Authors' abstract.)

742. Oxidation of wax in the foam phase with recirculation under laboratory and plant conditions. (In Russian.) I. G. Triandafilidi. *Khim. Tekh. Topliv i Masel*, Nov 1958, (11), 27–32.—The rate of oxidn of wax depends largely on the size of the contact surface, which is large in the foam phase. Recirculation of the wax in this phase made it possible to conduct the process at increased temp, improved the air–wax contact, removed undesirable oxidn products from the reaction zone, and reduced the air consumption. The optimum oxidn temp under these conditions was 140°. P. H. S.

743. WPRA refining quiz. 1. Catalytic reforming. W. L. Banks *et al.* *Oil Gas J.*, 23.2.59, **57** (9), 120.—A portion of the transcript of the two-day session of the regional meeting of Western Petroleum Refiners Association at El Dorado, Arkansas, is given. Among many questions answered were included such subjects as charging cracked stocks to cat reformers, detection of presence of cat poisons without closing down unit, use of inhibitors to reduce fouling, and chemical cleaning of plant. **2. Refinery maintenance.** W. L. Banks *et al.* *Oil Gas J.*, 2.3.59, **57** (10), 127.—Among questions answered in Pt 2 were operating control problems associated with use of air in direct coolant, pre-heat-exchanger fouling, causes and cure for vibration in coils of heater on hydrogenation pre-heat service, and prevention of fires in discharge of air compressors. G. A. C.

HYDROGENATION

744. The production of substances with a high aromatic hydrocarbon content by a hydrogenation method. (In Russian.) N. V. Goncharova *et al.* *Khim. Tekh. Topliv i Masel*, Lee 1958, (12), 15–21.—The optimal vapour phase hydrogenation conditions for a wide range of hydrogenated tars and of gas oils from cat processes has been determined. This makes possible the production of hydrogenates of high *mono*cyclic aromatic hydrocarbon content. When a chromium cat was used, max yield of aromatic hydrocarbons was obtained at a temp of 500° and a space velocity of 0·5–0·7 kg/l/hr. The chem composition of hydrogenated materials was studied and the amounts of individual aromatics in the 160° bp fraction were determined. G. W. T.

745. Hydrogenation of ethene and propene. (In German.) J. Muller and H. I. Waterman. *BrennstChemie*, 1957, **38** (21–22), 321–9; **38** (23–24), 357–62. Pt 1. Ethene hydrogenation. Pt 2. Propene hydrogenation.—Pt 1. C_2H_4 hydrogenation as carried out in the illustrated apparatus, with silicotungstic acid cat on silica gel supporter is discussed with supporting tables and charts. The influence of the following reaction variables is investigated: temp from 200° to 290° C, pressures from 10 to 15 atm, mol ratios C_2H_4/H_2O 0·5–6·5, spatial velocities 3000–12,500 l gas/l cat/hr and the % cont of C_2H_4 in the recycle gas between 98 and 20%, the balance N. The reaction is very temp sensitive and requires careful process regulation to prevent polymerization and resultant temp peaks. Max C_2H_4 conversion occurs between 250° and 275° C. The proportion of ethanol, expressed in wt % in the products, is obtained by dist and titration and compared with calc figures. Cat activity experiments with Co, Fe, Cu, and Cr salts of silicotungstic acid indicate that the Cu and Cr salts are nearly as effective as silicotungstic acid. 21 refs.

Pt 2. C_3H_6 hydrogenation as carried out in the illustrated apparatus, with silicotungstic acid cat on silica gel supporter, is discussed with supporting tables and charts. The apparatus differs slightly from that used for C_2H_4 hydrogenation. The influence of the following reaction variables is investigated: temp 160°–220° C, pressures 14·5–37 atm (abs), mol ratio C_3H_6/H_2O 0·9–2·8, spatial velocities 2000–11,100. The proportion of propanol expressed in wt % in the products is obtained by dist and titration. Cat activity shows no deterioration after 93 hr constant operation. Optimum yields of *iso*propanol are obtained at temp from 175°–190° C, high pressures, mol ratio C_3H_6/H_2O = 1·0, and high spatial velocities. 6 refs. R. T.

POLYMERIZATION

746. Stereospecific polymerization of conjugated diolefins. II. Polymerization of butadiene with catalysts prepared from alkyl aluminium and soluble vanadium chlorides. (In Italian.) G. Natta, L. Poris, and A. Mazzei. *Chim. e Industr.*, 1959, **41** (2), 116–22.—Stereospecific polymerization of butadiene has been carried out by means of cat prepared by reacting $Al(C_2H_5)_3$ or $Al(C_2H_5)_2Cl$ with vanadium chloride soluble in the polymerization solvent (VCl_4 or $VOCl_3$). The products consist mainly of 1,4 *trans* sterically pure crystalline polymers (mp 140°–145° C) and contain small percentages of sterically less pure 1,4 *trans* polymers of lower mp and lower degree of crystallinity, and of amorphous polymers. Activity and stereospecificity of cat prepared from $VOCl_3$ or VCl_4 are examined and compared with those of cat prepared from crystalline VCl_3, which was reported in a preceding paper. Whereas the stereospecificity of the cat obtained from the three different V chlorides is comparable, their activity is remarkably different and decreases as follows: cat from VCl_4 >cat from $VOCl_3$ >cat from VCl_3. (Authors' abstract.)

CHEMICAL AND PHYSICAL REFINING

747. Mass spectrometric analyses of medium-viscosity lubricating oils. M. L. André and M. J O'Neal, Jr. *Analyt. Chem.*, 1959, **31**, 164–9.—Medium visc oils derived from seven different crude oils were each separated into a saturated and an aromatic fraction, which were then analysed by mass spectrometry. All the oils contained *iso*alkanes. The V.I. ∝ *iso*alkane content and decreases, with a wide variation according to type, with increasing concn of aromatics and condensed *cyclo*alkanes. The change in composition with furfural extraction was studied. G. B.

SPECIAL PROCESSES

748. Utility boiler fired with delayed coke and coal. S. C. Brown. *Mech. Engng, N.Y.*, 1959, **81**, 31–4.—An agreement between a public utility and a refinery in the U.S.A. has provided a market for by-product fuel and an all-electric operation for the refinery; electric load, cooling water, and fuel for

the public utility. Burning characteristics of the delayed coke has been better than anticipated, with no indication of vanadium, sodium, or sulphur attack. Design features of the steam-generating unit to counteract the undesirable characteristics of the delayed coke have proved completely satisfactory. Considerable experience and information has still to be gained on burning coal and coke in combination, but this combination—fuel firing—is being investigated further to produce results that will be economical and efficient for operation. G. W. T.

749. Investigations on liquid fuel synthesis in the Petroleum Institute, China. (In German.) C. Ta-Yu, L. Nan-Tsuen, and Chang-Chun-Hao. *BrennstChemie*, 1957, **38** (23–24), 362–6.—Synthesis of liq fuels from CO and H_2 is discussed. Advantages and disadvantages of the fluid bed cat are described. The limited stability of conventionally produced fused or sintered Fe cat presents difficulties when choosing suitable cat. Data on experiments in a small testing installation, using a nitrated fused iron cat, indicate successful operation with good selectivity. CO cat were also investigated. Cat production temp is stated to influence cat activity greatly; samples prepared at lower temp are superior. 17 refs. R. T.

750. Fluidization. P. M. Heertjes. *Chim. e Industr.*, 1959, 41 (2), 101–8.—After a general discussion on fluidization, to evidence some problems and phenomena, the results of an investigation on drying of moist fluidized silica gel by air are exposed. It is shown that normally to the air flow, no temp and moisture gradients are noticed, and that mass and heat transfers take place only in a very narrow layer. Correlation between internal partial coeff of mass and of heat from one side, and Reynolds No. from the other side are reported; internal and external heat transfers are compared.

(Author's abstract.)

751. Petroleum chemicals. Special section. H. S. Burk *et al.* *Oil Gas J.*, 2.3.59, **57** (10), 91.—The first of four articles deals with interchange of materials on the Petroleum Chemical Corpn plant at Lake Charles, Louisiana, which is designed for full processing of the refinery by-product stream from two nearby parent-company refineries and serve as primary feeds. Each of the major plant's by-product streams are interchanged between plants; thus little is left unused. The second article concerns the production of high purity (99·7% +) ethylene with a single demethanizer and single ethylene fractionator, the offgases being produced in two streams, one rich in H_2 and the other in CH_4.

The third article deals with maintenance of safety requirements in ammonia plant using low-temp processing, ir analysers in air separation unit, monitor acetylene and other impurities in feed gas, air intake, and oxygen.

Finally, the instrumentation in ethylene oxide unit is described. The system is electronic, and close control is obtained by using special loops. Stream analysers are used in air separation plant for safety purposes. Flow sheets are given. G. A. C.

PRODUCTS

CHEMISTRY AND PHYSICS

752. Competitive adsorption of aliphatic compounds on water and silica surfaces. C. S. Brooks. *J. Coll. Sci.*, 1958, **13**, 522–36.—As a guide to the behaviour of the complex systems encountered in oil source beds and reservoir formations, the adsorptions of *n*-octadecane, *n*-octadecylamine, and stearic acid at heptane/silica interfaces have been examined.

There was no appreciable change in the adsorption of the amine and the acid when dry silica was replaced by silica covered with a monolayer of water (4·6 % wt). The presence of water completely prevented any adsorption of octadecane. Further additions of water (up to *ca* 54 mol layers) substantially prevented the adsorption of acid and reduced the adsorption of the amine. When the dry silica surface was pretreated with the acid and the amine, subsequent uptake of water vapour by the silica was much less than sorption by the untreated surface. H. C. E.

753. Elastomeric properties of ethylene–propylene copolymers. G. Natta and G. Crespi. *Chim. e Industr.*, 1959, **41** (2), 123–8.—Substantially saturated linear polyhydrocarbons, of good elastomeric properties, have been prepared by copolymerization of ethylene with α-olefins. The present paper refers in detail to the viscoelastic properties of ethylene–propylene amorphous copolymers, which differ remarkably from those of crystalline copolymers and of mechanical mixtures of the two homopolymers. These copolymers have good dynamic properties, also at very low temp; the flexibility of the macromolecules increases with increasing ethylene content, which is accompanied by a decrease of the minimum rebound temp.

(Authors' abstract.)

754. Temperature–pressure–structure effects on the viscosity of several higher hydrocarbons. D. A. Lowitz *et al.* *J. Chem. Phys.*, 1959, **30**, 73–83.—The visc of 14 very pure high mol hydrocarbon liq were determined at six temp, ranging from 37·78° to 135° C, and at pressures ranging from atm to 3400 bar by use of a rolling-ball viscometer. Hydrocarbons selected varied in mol wt from 268·5 to 535·0 and comprised several structural symmetry families involving progressive cyclization to *cyclo*hexyl, phenyl, and decalyl groups. Correlations were made of structure with visc, rate of change of visc with pressure, and enthalpy of activation for viscous flow. Paper also discusses the effects of mol wt and of mol structure on visc. G. W. T.

755. Analysis of light hydrocarbon mixtures. J. A. Barnard and H. W. D. Hughes. *Nature, Lond.*, 1959, **183**, 250.—Ethane, propane, ethylene, and propylene can be mutually separated on a chromatographic column consisting of a mechanical mixture of a saturated soln of $AgNO_3$ in ethylene glycol supported on Celite (*A*) and tri-*iso*butylene on Celite (*B*). *A* serves to separate the olefins from the alkanes, and *B* separates the C_3 from the C_2 components. The column dimensions are 4 m by 6 mm i.d. and the carrier gas is N_2 at 0·4 l/hr. H. C. E.

ANALYSIS AND TESTING

756. X-ray determination of sulphur in oils. Comparison of X-ray emission and absorption methods. W. R. Doughman, A. P. Sullivan, and R. C. Hirt. *Analyt. Chem.*, 1958, **30**, 1924–5.—The two methods compared for the determination of S in the concn range 0·1 to 1·2% in petroleum were: (1) excitation of the sample with X-rays from a tungsten target and measurement of the intensity of the K_α line, and (2) measurement of the absorption of X-rays produced by an ^{55}Fe source free from ^{59}Fe. The two methods are equal in accuracy, precision, and rapidity. The standard deviations of both methods are: accuracy (deviation from known value), 0·038% S; repeatability, 0·031%. The absorption method uses cheaper apparatus and requires less skill, but is more subject to interferences. G. B.

757. Separation of saturated hydrocarbons from petroleum residues. R. D. Schwartz and D. J. Brasseaux. *Analyt. Chem.*, 1958, **30**, 1999–2002.—The crude oil residue dissolved

in *cyclo*hexane is passed without preliminary separation through a chromatographic column packed with a bed of silica gel of mean pore dia 140 Å above a bed of silica gel of mean pore dia of 22 Å. Naphthenic and resinous materials are adsorbed on the large pore adsorbent and the simpler aromatics on the small pore adsorbent. The saturated hydrocarbons can be eluted with *cyclo*hexane. The effluent contains <5% of aromatics. G. B.

758. Estimation of types of nitrogen compounds in shale oil gas oil. G. U. Dinneen, G. L. Cook, and H. B. Jensen. *Analyt. Chem.*, 1958, **30**, 2026–30.—The N cpds of the gas oil fraction (C_{15} to C_{30}) were isolated by Florisil adsorption, separated by mol dist and thermal diffusion, and characterized by their mass spectra, u.v. spectra, mol wt, and by elementary and functional group analysis. The N cpd concentrate comprised 43% of the crude oil and contained 80% of the original N. Pyridines, dihydropyridines, indoles, and quinolines comprised more than half of the N cpds in the gas oil. Much of the remainder consisted of cpds with saturated rings condensed with these cpds. Small amounts of cpds containing three aromatic rings were present. Many of the cpds contained O, mostly in phenolic groups. G. B.

759. Measurement of burning rate of gelatinized petroleum. K. Cree and R. F. Scrutton. *Chem. & Ind.*, 1959, 326–7.—Description with sketch of an apparatus which provides a continuous measurement of the unconsumed wt of a burning petroleum material. The combustion pan (2½ inches dia × ½ inch deep) is suspended by nichrome wire from a spring steel strip. Deflection of the strip is measured with a displacement pick-up and direct reading measuring bridge. The strip is largely protected from the heat of combustion by deflector plates and insulation, and variation due to this is <0·1 g. When *ca* 10 g was burned, readings (±0·2 g max) fell on a smooth curve. W. A. M.

760. Control of engine lubrication by testing used oils. (In French.) A. Schilling, B. Bernelin, and C. Fosse. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1217–42.—Methods for examining used oils from diesel and petrol engines are described. These include examination of a drop of oil on a filter paper; after several hr the drop is resolved into various zones which can be qual interpreted to indicate amount of fouling and activity of detergent additive. Drops are deposited at 20° C and at 200° C. Drops of oil are also examined microscopically at ambient temp and after heating to 200° C, then cooling to ambient temp. Size of carbonaceous aggregates can be determined, also presence of foreign matter. Content of carbonaceous matter is determined photometrically. Method previously described (*cf.* Abs. **2055**, 1958) has been simplified; two standard drops of oil are diluted with 14 ml of C_6H_6 and optical *d* is compared visually with Wratten filters of known optical *d*, using a comparator. The filters are calibrated directly in % carbonaceous matter in steps of 0·2%. If a significant amount of water is present in the oil, the C_6H_6 is replaced by 10% ethanol/90% C_6H_6. The above methods were applied to the study of artificial "used oils," and effects of carbonaceous matter, water and water/glycol, and abrasives are described and fully illustrated. The effects on engines in service of load, mileage, oil consumption, malfunctioning of an injector, oil filtration, contamination with water and with water/glycol, and presence of abrasive and metallic particles are similarly described and illustrated. Dilution cannot be detected by the methods used. Illustrations are given covering the life of a detergent oil in an engine test run, and correct oil change period is deduced therefrom. W. A. M.

761. Application of radioactive tracer technique to the study of piston ring wear. (In French.) J. Thiéry. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1197–216.—Advantages of radioactive tracer methods over previous physical and chem methods for study of piston ring wear are enumerated. Basis of method is outlined, and brief descriptions are given of irradiation of piston rings, types of radiation emitted thereby, methods of detection, and safety precautions. Tests were carried out using a Petter AV 1 diesel engine. In the first apparatus used the whole of the sump oil was circulated through an ext chamber, the detector being located near by. In a second apparatus gutters were installed immediately below the piston skirt so as to collect *ca* 60% of the oil falling from the cyl, and this oil was pumped away at such a rate that the gutters neither overflowed nor ran dry. The oil passed through a coil near to a detector and was collected in a graduated cyl, corresponding amounts of new oil being added to the engine. Methods of interpretation of results using the two techniques are given. Applications of the method and the validity of the results obtained are discussed. W. A. M.

762. Review of gas–liquid chromatography. C. J. Hardy and F. H. Pollard. *J. Chromatog.*, 1959, **2** (1), 1–43.—The published work on the theoretical principles, apparatus, techniques, and applications of gas–liq chromatography is critically reviewed and 619 refs are given. G. B.

763. Continuous gas chromatography (process for the continuous separation of a multicomponent mixture in a two-phase countercurrent system with temperature gradient). Pt 1. (In German.) W. Kuhn *et al.* *Helvet. Chim. Acta.*, 1958, **41**, 2135–48.—A process is described which enabled continuous separation in a single stage. Basically it depended on a system of two miscible phases flowing countercurrent to one another. A temp gradient was maintained along the axis of the system. Because of the temp dependence of the partition coeff, at a given temp, the effective material transport for any individual component was zero, so that the component would accumulate at the corresponding point on the temp gradient. Very similar substances could be separated. P. H. S.

764. The accurate measurement of the viscosity of liquids. Anon. *J. Inst. Petrol.*, 1958, **44**, 394–400.—Seven papers, read at a symposium on the accurate measurement of visc of liq, are summarized. Paper 1 deals with the oscillating vessel method for determining abs visc and paper 2 with an electronic counting technique which is particularly suitable for measuring small changes in visc. In paper 3 experiments are described indicating the effect on the coeff of visc of altering the rate of shear; paper 4 is concerned with the measurement of visc of polymers at extremely low concn. In paper 5 the precise measurement of kin visc in the petroleum industry, types of viscometers, thermostat baths, and electronic timing devices are described. A short report on standard methods of measuring visc in c.g.s. units formed the subject of paper 6, and in paper 7 a method is outlined for obtaining the true constant of a viscometer. A. D. S.

765. Polarography of aromatic hydrocarbons. H. J. Gardner. *Nature, Lond.*, 1959, **183**, 320–1.—The polarographic waves of aromatic hydrocarbons dissolved in a variety of solvent mixtures can be described by the Kolthoff–Lingane eqn. The similarity between this eqn and that derived on the basis of a two-electron reduction mechanism shows that the potential-determining stage of the reduction is due to the uptake of two electrons. A. D. S.

766. Determination of platinum in catalysts by a colorimetric method. (In Russian.) Ya. E. Shmulyakovskii. *Khim. Tekh. Topliv i Masel*, Dec 1958, (12), 56–8.—Paper describes a simple, accurate, and rapid colorimetric method. The cat is baked at 1100° C to transform α-Al_2O_3 into an insol form. It is then digested in aqua regia and filtered. Stannous chloride is added to obtain a yellow soln suitable for colorimetric determination. P. H. S.

767. Determination of the density of petroleum fractions by the "rising drop" method. S. Facchetti. *Riv. Combust.*, 1958, **12** (12), 917–25.—The determination of the density of liq available only in small quantities is accompanied by considerable difficulty. With the method and equipment described in this article, variations of those proposed by Gottfried Nettesheim of the Institut für Chemische Technologie at the Technische Hochschule, Aachen, the density of liq, immiscible with and lighter than water, can be easily determined on samples of *ca* 0·03 ml. The method of the "rising drop" is adopted, which is based on measurement of the rise time of drops of given size in appropriate liq, in this case water. (Author's abstract.)

CRUDE OIL

768. Identification of low-boiling sulphur compounds in Agha Jari crude oil by gas–liquid chromatography. H. J. Coleman *et al. Analyt. Chem.*, 1959, **30**, 1592–4.—Eleven S cpds in the boiling range 38°–100° C have been identified by GLPC and eight of these confirmed by mass spectrometry. The S concentrate was obtained from the crude oil under conditions which would not lead to the formation of the cpds found, and they are believed to have been originally present in the crude oil. G. B.

769. Aromatic hydrocarbons in the 170° to 180° C fraction of petroleum. B. J. Mair *et al. Analyt. Chem.*, 1958, **30**, 1814–17.—The aromatic component of the 170°–180° C fraction of the representative petroleum being examined by the API Research Project 6 has been completely analysed. The aromatic portion was separated by adsorption on silica gel and fractionated by dist, including azeotropic dist with ethylene glycol monobutyl ether, and adsorption on silica gel. The individual cpds were identified by measurement of their physical properties and by ir spectrometry. The compounds identified were 1,2,3-trimethylbenzene, 54·5%; 1-methyl-3-*iso*propylbenzene, 22·6%; 1-methyl-4-*iso*propylbenzene, 12·1%; *sec*-butylbenzene, 5·0%; 1-methyl-2-*iso*propylbenzene, 2·5%; *iso*butylbenzene, 2·4%; and indan, 0·9%. These constituted the whole of the aromatic portion and amounted to 0·35% of the crude oil. G. B.

770. Rapid method for the determination of sodium chloride, calcium chloride, and magnesium chloride in crude oil. A. Piccinini. *Riv. Combust.*, 1958, **12** (12), 926–31.—The author describes his experiments in studying a quick method for separate chemical assay of the sodium chloride, calcium chloride, and magnesium chloride in crude oil. Assay of the total chlorides is performed by the Volhard and the Mohr methods after extraction with water. The calcium and magnesium are assayed separately by a volumetric method based on the use of the disodium salt of ethylenediaminetetraacetic acid. The sodium is assayed by difference. (Author's abstract.)

GAS

771. Liquified natural gas. Pts VIII and IX. Anon. *Petrol. Times*, 13.2.59, **63** (1605), 106; 13.3.59, **63** (1607), 156.—This article draws attention to the Nov 1958 edition of the *Brit. Weld. J.*, which contains "Recommendations for the X-ray Examination of Fusion-Welded Joints in Light Alloys." Four important research papers are also referred to as well as an article (translated from the Russian) on "Welded Joints and Residual Stresses."

Summaries in the form of introductions and conclusions from the four papers are given, the subjects being low temp properties of welded and unwelded aluminium/5% Mg alloy plates, extruded aluminium alloys for low temp service, tear tests on aluminium magnesium alloy plate, and low temp properties of Al/Mg alloys.

Principal conclusions are that very low temp prolong the process of general elongation; when brittle failure occurs the crack rapidly extends; a particular alloy tested is not seriously embrittled or notch sensitive at low temp; and tests show increase of strength and ductility of the alloys tested with decrease of temp.

In Pt IX the nearness of the Sahara gas deposits to European energy markets is considered particularly in regard to its transport by pipeline. The deposits should provide an assured minimum annual output of 530,000 million cu ft of gas. N. Africa would be the first to benefit under the scheme. The Mediterranean presents a formidable natural obstacle, and one solution is an underwater tunnel at Gibraltar, where the distance is only 7½ miles across, costing £8½ million. Another is a crossing by several 12-inch pipelines at the Straits (*ca* 18 miles).

It is estimated that the gas could be delivered in Strasbourg for 3·14*d* per therm. By tanker the cost would be 4·3*d* a therm. The Economic Cttee concerned view the venture favourably, especially since energy requirements of the OEEC countries are growing, and their recommendations have been adopted by the Consultative Assembly.

Tables are provided, and one shows concessions in the French Sahara at the end of 1958. A map is also given. G. A. C.

772. Crude benzene recovery in the remote gas pressure stage of the coke plant. (In German.) T. Haber. *Brennst-Chemie*, 1957, **38** (23–24), 366–71.—Various benzene recovery systems are described with plant illustrations. The operational economy of benzene recovery can be viewed only in the frame of total benzene recovery of a gas plant on both the low and high pressure side. This is influenced widely by fluctuations in remote gas delivery. Current apparatus can be utilized with a combination of remote gas compression pressure and the cooling necessary for gas drying, with a suitable absorption means. The economy of benzene recovery in view of falling prices is discussed. R. T.

ENGINE FUELS

773. Organic chromates as additives for temporary petroleum-based corrosion inhibitors. (In Czech.) R. Bartonicek and I. Cerveny. *Chem. Prum.*, 1958, **8**, 622–7.—Experiments showed that the degree of sol of the additive in the inhibitor is the deciding factor for the inhibiting activity of chromates. The minimum sol value is a concn of 2 g organically bound chromate in 1 kg of inhibitor. Empirical experiments with inhibitors made from esters of chromic acid with tertiary alcohols gave excellent results. P. H. S.

GAS OIL AND FUEL OIL

774. Sulphuric acid corrosion in oil-fired boilers—studies on sulphur trioxide formation. D. R. Anderson and F. P. Manlik. *Trans. Amer. Soc. mech. Engrs*, 1958, **80** (6), 1231–6.—Factors controlling the oxidn of SO_2 to SO_3 were investigated in a small experimental boiler. A dist oil was used and synthetic cpds were added to simulate sulphur and metallic cpds normally found in residual oils. The SO_3 content of the flue gases was determined indirectly by measuring the corrosion and sulphate disposition on a steel specimen maintained at a controlled temp. Nickel, iron, sodium, and vanadium in the fuel each decreased the corrosion normally experienced, the magnitude of the effect increasing in the order given. Deposits of these metallic fuel-ash components in the boiler had a relatively small effect on corrosion of the test specimen. Only iron deposits showed significant cat activity for the oxidn of SO_2 to SO_3. Combinations of sodium and vanadium decreased corrosion in an initially clean furnace, but boiler deposits from certain combinations of these elements increased

corrosion substantially. This cat effect is predominant over extended periods of time. A. D. S.

775. Fuel problems in merchant ships. Anon. *Petrol. Times*, 13.3.59, **63** (1607), 169.—Extracts from a paper by W. McClimont at the Institute of Fuel, Jan 1959 meeting, are given, and include problems in boilers, diesel engines, and gas turbines. Boiler problems include damage to brickwork, deposition, and corrosion in superheaters and air heaters. It was thought that the sodium found in slag comes from sea water, but water vapour in heavy weather conditions may be a cause. Use of additives to prevent superheater troubles have been considered but no significant has been work done.

Wear and fouling problems in cyl have been tackled by raising cyl jacket temp and by use of additives.

The development of gas turbines has been retarded by blade corrosion and deposition of combustion products. Removal of sodium from the fuel and addition of magnesium sulphate to inhibit vanadium attack have combated corrosion and the water-washing process has reduced ash deposition.

G. A. C.

LUBRICANTS

776. Hydrodynamic lubrication of roller bearings. J. F. Osterle. *Wear*, 1959, **2** (2), 195–202.—A hydrodynamic theory with some simplifying assumptions is developed for the lubrication of cyl roller bearings. Expressions are derived for max film strength, load capacity, frictional drag, and coeff of friction. Visc variations, surface roughness, and surface deflection are not considered and constitute limits to the scope of the theory. G. B.

777. The effect of lubricants on the "wear in" of new machinery. (In German.) A. Sonntag. *Schmiertechnik*, 1958, **5**, 267.—The problem dealt with in this paper is the control of abrasion and permanent damage during "wear in," which is the term used to describe the first phase in the life of new machinery. During this critical period surface damage, known as "galling," "scuffing," "scoring," and "seizing," may occur. To reduce these hazards, past engineering efforts have brought about innovations in surface finishes and surface coatings. A lubricant composition with a high concn of MoS_2 (Molykote Type G) is recommended as a "wear in" lubricant. P. H. S.

778. Coolants for chucking automatics. Anon. *Auto. Engr*, Feb 1959, **49** (2), 72–3.—With high-speed steel tools neat cutting oils are adequate under normal conditions. With sintered carbide tools, higher cutting speeds are essential, and neat cutting oils tend to vaporize and form objectionable fumes. Under these conditions soluble oils are practical, providing that a careful selection of the oil is made.

A. D. S.

779. Correlation of bench oxidation tests with transmission test performance of automatic transmission fluids. E. G. Foehr and S. R. Calish. *SAE Paper* No. 135, 1959.—Investigations have shown that a slightly modified Allison Type C oxidation test could be used to predict more accurately the stability of transmission fluids in automatic transmissions, and also to screen rapidly transmission fluid composition variables at relatively low cost. Application of this test has led to the development of transmission fluids which are very stable and clean in oxidn tests run at 350° F. G. W. T.

780. An investigation of piston-cylinder and shaft-bearing friction at low temperatures. M. P. Volarovich. *Wear*, 1959, **2** (3), 203–16.—The friction of a lubricated ICE piston and of a plain journal bearing has been studied at temp down to −60° C for ten different oils. The piston required a very high initial force to shear the oil on the first stroke. Apart from this, the oils behaved in agreement with hydrodynamic lubrication theory. For normal starting of ICE, the oil should not have a visc of more than *ca* 100 poise at the starting temp. The rheological properties of the oils at low temp were studied in a rotating cyl viscometer. All oils at low temp exhibit a static yield value and decreasing visc with increasing rate of shear. The structure causing this behaviour is easily broken down by stirring, after which the oils behave as Newtonian liq. G. B.

781. Petroleum-based launching lubricants. G. H. Clark and D. A. Davidson. *Petrol. Times*, 13.2.59, **63** (1605), 103.—A summary is given of the paper presented to the IP on 7.1.59 on the development, testing, and application of petroleum-based launching lubricants.

The lubricant must support the entire weight of the ship and prevent wood-to-wood contact during the vital seconds as the sliding ways proceed down the standing way until the ship floats on the water.

Traditional lubricants, such as animal and vegetable fats and oils, have disadvantages, and new ones to deal with heavy loads involved application of a petroleum wax fluid base coat applied hot and a "slip coat" lubricant applied to minimize friction, the latter being a lime–soap grease.

Lab tests of the products include penetrometer tests and determination of the coeff of static friction. G. A. C.

BITUMEN, ASPHALT, AND TAR

782. Adhesion in bituminous road materials: a survey of present knowledge. D. H. Mathews. *J. Inst. Petrol.*, 1958, **44**, 423–32.—Extent of present knowledge on adhesion in bituminous materials is surveyed. Subjects covered include adhesivity in the absence of water, factors affecting adhesion in bituminous road materials, physico-chemical properties of system water–stone–binder, adhesion tests, and effect of additives on adhesion. Aspects requiring further study, including dry adhesion, merits and reproducibility of adhesion tests, failure of bituminous materials in presence of water, prevention of stripping in coated materials, and a better understanding of the water–stone–binder system, are reviewed. A. D. S.

783. Progressive alterations in a sheet asphalt pavement over a long period of service. J. T. Pauls and W. J. Halstead. *Publ. Rds, Wash.*, Feb 1959, **30** (6), 133.—Progressive changes in characteristics of the asphalt and the measurable physical properties of a sheet asphalt pavement have been studied over a 19-year period. Tests show that a large proportion of the hardening of the asphalt occurs during mixing and rolling; and overall age-hardening did not appear to be directly related to the kind of asphalt used. Density of the pavement and stability of sample cores increased with time under traffic action, rate of increase being greater in early life of the mix.

Greatly increased traffic, together with hardening of asphalt, resulted in loss of a significant amount of surface materials in later years. G. A. C.

DERIVED CHEMICAL PRODUCTS

784. Elements in petrochemical expansion. Anon. *Petrol. Press Serv.*, 1958, **25**, 294–7.—The petrochemical industry—despite striking growth—has assumed significant size in only seven countries outside the Soviet bloc. Limited projects have reached or are nearing completion in some countries, in others they are planned. The industry assumed prominence in the U.S.A. and Canada during world war II, in W. Europe a decade later. In the U.S.A. output of basic org chemicals from petroleum hydrocarbons in 1951 totalled 8·6 billion lb, in 1957 *ca* 18 billion lb. OEEC put 1957's total petrochemical production—expressed in output tonnages in terms of C cont of primary products—for European member countries at 630,000 tons, against 208,000 tons in 1953, and expected

830,000 tons for 1958. In the org chemical sector petrochemicals are displacing coal and vegetable counterparts, *e.g.* ethylene and butadiene production. Some new synthetic fibres are produced entirely from petroleum basestocks. An advantage of petroleum hydrocarbons over other source materials for chemical manufacture is their higher H–C ratio. Chemicals can be made also more cheaply from oil refinery and natural gas than from other raw materials. Preconditions for setting up petrochemical enterprises are determined by numerous interconnected factors. The main determinants are: amplitude and production costs of liq and gaseous hydrocarbons available, distances between raw-material sources, process facilities, and principal consuming regions, transportation costs of basestocks and end products, domestic demand and export prospects for chemicals, and competitiveness of locally-produced petrochemicals with chemicals produced from other sources. The decisive bearing which interplay of these factors may have upon planning new petrochemical projects is demonstrated by a study of Canadian developments. R. T.

785. Production of acetylene and ethylene from hydrocarbons. Anon. *Industr. Chem.*, 1959, **35**, 70–4.—Description with simplified flowsheet of SBA process for manufacture of C_2H_2 from CH_4 and C_2 gases by partial oxidn, and of C_2H_2 and C_2H_4 from higher hydrocarbons by thermal cracking in an atm of superheated steam. Principal feature of equipment is a novel type of furnace with tubular mixing elements which are claimed to give efficient mixing of reactants very rapidly. When partial oxidn is used, the pyrolysis is stopped by injecting cold water at the side. Soot is removed by a continuous film of water maintained on a lateral partition which divides the furnace into a combustion chamber and a pyrolysis chamber. Products are purified by washing with water and oil to remove soot and tar, removal of CO_2 by washing with aq NH_3 and of C_2^+ hydrocarbons with kerosine, and selective absorption of C_2H_2 in anhyd NH_3, from which the C_2H_2 can be recovered. Purification of products from partial oxidn is carried out at atm pressure; from thermal cracking at 8 atm. C_2H_4 is separated from the residual gas by refrigeration. The processes have been successfully operated on the industrial pilot plant scale; full-scale plants are being built. W. A. M.

786. Some questions concerning the establishment of the petrochemical industry. IV. P. Gustavson. *Kemija u Industriji*, 1959, **8** (2), 37–9.—In this fourth report the author deals with the choice of phenol synthesis processes. It is the author's opinion that of the four basic processes (Raschig, benzene sulphonate, cumene, and chlorobenzene processes) the cumene and benzene sulphonate processes are to be taken into consideration as the most favourable for Yugoslav conditions. With the establishment of the petrochemical industry, however, only the cumene process from benzene and propylene would be of interest for the phenol synthesis.

(Author's abstract.)

MISCELLANEOUS PRODUCTS

787. New method for evaluating the behaviour of transformer oils in use. (In Russian.) K. I. Ivanov *et al.* *Khim. Tekh. Topliv i Masel*, Dec 1958, (12), 46–8.—A new method has been developed for evaluating the behaviour of these oils under conditions similar to those found in practice, in relation to their physico-chemical and electro-physical parameters. It consists essentially of following the aging of the oil in a specially constructed transformer. Using this method for the first 100 hr, the tendency to form low mol wt water-sol acids may be characterized, and for the following 650 hr their behaviour during protracted working. Studies have been made on the influence of the method of refining an oil on its working properties, the effect of an electrical field on the aging of oils, and the effectiveness of a number of anti-oxidant additives. G. W. T.

ENGINES AND AUTOMOTIVE EQUIPMENT

788. Abnormal combustion in high compression single-cylinder engines. R. W. Young. *SAE Paper* No. 105A, 1958.—Runaway pre-ignition is a potentially destructive form of abnormal combustion that can occur in essentially clean combustion chambers in the absence of surface ignition. It is characterized by a lack of ignition control and a violent, audible noise. Investigation of this phenomenon led to the following conclusions: (1) The fundamental cause has not been determined. It is believed to be brought about by factors which promote increased temp and pressure of the fuel–air mixture, causing the initiation of spontaneous ignition. (2) Runaway pre-ignition is promoted by the following engine design characteristics: high C.R. and non-turbulent combustion chamber configuration. (3) It is effected by the following engine operating conditions: load, speed, spark advance, and fuel–air ratio. (4) Although this form of abnormal combustion does not appear to respond to the octane quality of the fuel, it is affected by fuel type. G. W. T.

789. Weather or stall carburettor icing control. D. P. Barnard and E. H. Scott. *SAE Paper* No. 6R, 1959.—Work is to be continued in the area of additive investigation, and in the near future the test will be transferred to the cold room. The conclusions based upon the work completed to date are as follows: (1) carburettor icing field performance can be evaluated in the laboratory; (2) the range of weather conditions affecting carburettor icing severity is the combined effect of temp, evaporative cooling, and absolute moisture content of the atmosphere; (3) the entire ASTM dist range effects the carburettor icing tendency of a given gasoline; (4) synergistic qualities of additives with respect to anti-icing quality have been discovered. G. W. T.

790. Warm-up test instrumentation in the laboratory. K. A. Frassa and C. R. Small. *SAE Paper* No. 68, 1959.—A method of instrumentation, using magnetic tape to programme a test cycle and a strip chart recorder to record engine performance, has been developed and applied to the evaluation of the warm-up characteristics of passenger cars on a chassis dynamometer. The relative effects of fuel volatility on warm-up, as well as an absolute measure of car performance, can be obtained. Although substantiating data are not presented in this paper, experience has shown that the chassis dynamometer tests are more reproducible than the road tests. Reproducibility of the tests in terms of ml to warm-up was 0·4 on the dynamometer as compared to 0·6 on the road. In addition, automatic instrumentation discussed reduced the manpower requirements necessary to conduct such tests and provided efficient round-the-clock testing regardless of weather conditions. G. W. T.

791. Flow meter for liquid fuels. D. N. MacDougall and K. Weiss. *Auto. Engr*, Feb 1959, **49** (2), 66–8.—A flow meter is described which is capable of measuring mean fuel flow with a high degree of accuracy. Equipment, which embodies a device for automatic refilling of the measuring vessel, can be used for lab work and for making fuel consumption checks in industrial installations. Circuit diagrams and photographs are given. A. D. S.

792. Pulsation damping on reciprocating compressors. R. E. Mayne. *Pipe Line News*, Jan 1959, **31** (1), Insert 9.—Pulsation problems in installations utilizing reciprocating type compressors may not only be of a hazardous nature, but can adversely affect operating efficiencies seriously enough to become an economic problem.

A new approach to this problem has been made and resulting from the present work an electro-acoustical analogue which simulates compressor plant operations has been developed.

The paper presents a semi-technical discussion of gas pulsation causes and effects, and outlines a new approach towards the solution of this problem. It also gives the description of the electro-acoustical analogue and the basic data obtainable with the analogue. The latter are as follows: (1) pressure *v.* volume diagram; (2) complex wave forms generated by the compressor; (3) frequency analysis of the pressure wave; and (4) frequency transmission characteristics of the system.

The analogue variables which are programmed for a gas pulsation problem are: (*a*) reciprocating machine speed; (*b*) compressor cyl crank angle arrangement, bore, stroke, rod dia, fixed clearances, and unloaders; (*c*) suction and discharge operating pressures and temp; (*d*) sp gr, ratio of specific heats, and supercompressibility of the gas being compressed; and (*e*) the lengths and inside dia of the complete piping system.

M. F. M.

793. New type of oil-control ring. Anon. *Gas Oil Pwr*, 1959, **54**, 59.—The usual type of slotted scraper ring, fitted to pistons of short stroke, tends to become overloaded so that oil is lost to the combustion chamber. This new ring is so designed that, on the upward stroke, oil from the cyl wall is forced through drainage holes in the ring and escapes through holes in the piston. The top land of the ring is radiused at the upper corner.

H. C. E.

SAFETY PRECAUTIONS

794. Fluids in torches. H. Allen. *Fluid Handl.*, Feb 1959, (109), 37–8.—Safety precautions for storing and handling C_2H_2, kerosine, LPG, and petrol in blow torches and plumbers' furnaces are briefly enumerated.

W. A. M.

ECONOMICS AND MARKETING

795. U.K. liquid imports and exports in 1958. Anon. *Petrol. Times*, 13.2.59, **63** (1605), 111.—Tables and graphs are given relating to U.K. oil trade and concern motor spirit, kerosine, lub oil, gas, diesel, and fuel oils, and include figures for re-exports and imports of products made in the U.K.

G. A. C.

796. Linear-programming model for refinery simulation. C. R. Nichols. *Oil Gas J.*, 9.2.59, **57** (7), 101.—A hypothetical refinery (cat cracker) with a flow pattern, characteristics, product requirements, and economic factors is defined and the problem is posed of how the refinery should be operated to realize max profit whilst meeting all requirements.

A linear-programming "model" is built in which a set of linear equations defines the restrictions on a system of variables, the latter being greater in number than the restricting equations so that many different solutions may satisfy the restrictions.

Material balances, cat cracker yields, refining qualities, TEL functions, and economics are tabulated and taken into account in arriving at the solution, points from which include the findings that the max crude capacity is not utilized, the reformer is operated at full capacity but low severity, and fuel oil return is so low that it would be more profitable to throw away the residuum than to use the cutter stock required to blend to specification.

G. A. C.

MISCELLANEOUS

797. Petroleum techniques for steel. F. D. Hoffert *et al. Mech. Engng, N.Y.*, 1959, **81**, 27–30.—The H-Iron process, using hydrogen as the reducing agent, incorporates standard petroleum refinery construction practice and processing economics and is fully competitive with the blast furnace both in fuel efficiency and in unit capacity. This development is of interest to the petroleum industry, since it provides a potential outlet for petroleum products and may permit refiners to find more economic uses for gases and heavy residues from crude oil processing.

G. W. T.

798. New perspectives in Iraq. Anon. *Petrol. Press Serv.*, 1958, **25**, 288–91.—The political upheaval in Iraq will probably not interfere with basic economic facts re domestic oil. Arab extremists favour nationalization; the Government—anxious only for continuous oil flow—does not lend support, and results of the new sympathy with the United Arab Republic are problematical. The latest crisis has not affected the security of outlets crucial to Iraq oil production. The pre-Suez level of 25 million tons p.a. exports from the N. field has been reached recently. Limited tanker accommodation at Fao—tankers only up to 26,000 tons—hampers exports from the S. fields. Massive enlargements of oil export facilities in the Persian Gulf are under construction or planned. Declining pressure at Kirkuk field is boosted by gas and water drive and at Butmah field by gas. Search for new fields is being renewed with ill-rewarded persistence in concession areas. Refining and marketing are in Government hands. The non-profit-making policy is criticized, but it is claimed that the £4 million Dourah plant saves imports costing £2 million p.a. A new £7 million plant at Kirkuk to be built in 1960 will process 80 million ft^3 of Iraq's gas. Liquefied gas and gasoline will be produced. Two large thermal power stations to run on gas or oil are being built near Kirkuk and at Baghdad. Iraq has used her oil revenues in recent years to lay the foundation of the country's economic development. The new leaders have declared that existing oil arrangements with western companies are in no danger of renunciation.

R. T.

799. Pakistan: help from gas. Anon. *Petrol. Press Serv.*, 1958, **25**, 291–4.—The Five-Year Plan (1955–60) has been revised recently to cut expenditure from Rs 11,600 million to Rs 10,800 million. Among measures adopted to provide more funds for development, the budget doubled import duty on cars and spares, and raised the duty on fuel and light diesel oil. Owing to adverse international markets for her exports, Pakistan is dependent on foreign aid for development purposes and many current imports. Petroleum products are being imported ~1·7 million tons p.a., costing *ca* Rs 263 million. Local production is only 300,000 tons p.a. from four small fields, all in the N. of W. Pakistan; this is refined at Rawalpindi. Some foreign exchange saving is expected from a project by marketing companies to build a jointly-owned

refinery large enough to meet W. Pakistan's requirements. Economy may suffer from local surpluses of light products. Consumption of all petroleum products in the E. province is only 400,000 tons p.a. Increase of gasoline consumption by 9% in 1957 includes a large offtake at Karachi airport. In both E. and W. Pakistan diesel oil consumption is rising rapidly, due to use by road vehicles, river craft, and the railways. Despite dieselization—supported by World Bank loans—the railways still account for *ca* ⅓ of fuel oil used. Plans are in hand for increasing electricity supplies to the towns. The Sui gas field—production *ca* 11,000 million ft³ of gas in 1957—contributes largely to W. Pakistan's economy. Two 16-inch pipelines have been laid, one running S. to Karachi, and one N. to Multan, to be extended later. In E. Pakistan a gas field has been discovered at Sylhet, the gas from which will be used for making fertilizers. Search for oil—with Government participation—is being pursued in both parts of Pakistan by foreign companies. R. T.

BOOK REVIEWS

Fluid Dynamics and Heat Transfer. James G. Knudsen and Donald L. Katz. New York, Toronto, London: McGraw-Hill Book Co., 1958. Pp. ix + 576. 97*s*.

One of the most significant features in the development of university engineering courses since the war is the increasing prominence given to the study of transfer processes, in particular those which depend upon fluid dynamics. The chemical engineers and aeronautical engineers have always emphasized the importance of these, and now the civil and mechanical engineers are beginning to acknowledge that a few well-worn lectures on "hydraulics," supported by examples and a stereotyped laboratory course, are not enough. As we would expect, there have appeared in recent years a number of books on these topics; most of these have been somewhat specialized texts more suitable for research students and for advanced workers in the field. The book by Knudsen and Katz will be welcomed because it really is suitable for the high level honours undergraduate or immediate post-graduate student. The assumption is made that the reader is already acquainted with the usual elementary theory of fluid mechanics and heat transfer and with the methods of mathematical analysis, although, following the example of a well-known British textbook, the most important mathematical methods are described in an appendix. It is clear from the text that the book is based on the authors' teaching experience; great care is taken to discuss at some length topics which students find difficult to understand.

The book is divided into three sections: (1) basic equations and flow of non-viscous fluids; (2) flow of viscous fluids; (3) convection heat transfer. About half of the text is devoted specifically to fluid dynamics, with particular emphasis on the sections not usually emphasized in older texts, such as laminar flow in non-circular conduits, turbulence, and boundary layer theory. The section on the incompressible flow past immersed bodies is particularly thorough. The phenomenon of heat transfer is considered wherever possible as a consequence of the fluid dynamics of the situation, so that there is emphasis on convective transfer and on analogies between the transfer of heat and momentum. There are a number of useful and imaginative examples for working out which will be very welcome to both teachers and students. To sum up, no better book on this topic has appeared so far. E. S. S.

Guide du Pétrole et de son Equipement. Tome: Reglementation. Paris: Editions O. Lesourd, 1959. Pp. 752. Fr. 6500 (postage fr. 220).

This is the second volume to appear of the current edition (*cf. J. Inst. Petrol.*, 1958, 241A, for note on the first volume); the text is stated to be revised to 1 Jan 1959.

The book is divided into 14 sections and, as befits the title, most of these are concerned with the large mass of detailed official control with which the French petroleum industry appears to be saddled. Instead of the legislation concerned with petroleum being, as in the U.K., mainly restricted to customs and safety requirements and to control of production, French law goes to the extent of laying down quality standards for many products instead of relying upon these being maintained by normal commercial considerations. For example, the octane rating of premier grade gasoline has to fall within the narrow limits of 91/93 (F_1), and the ordinary grade has a minimum of 81; diesel fuel has to have a minimum cetane value of 50 and a maximum pour point of −10° C, and there are standards laid down for several other products, including LPG. Prices for all products are controlled, including lubricating oils, the quality of which, however, appears to be free from official supervision.

It is interesting to note that special fiscal provisions apply to aromatic extracts.

Even the hundreds of pages of regulations in the volume under review do not suffice to cover all those that the French government has issued and in the case of certain regulations which have not changed (*e.g.* concerning aircraft fuelling) the reader is referred to earlier editions of the "Guide du Pétrole."

A 32-page supplement gives the recent law covering petroleum search in the Sahara.

A section is devoted to filling stations, covering regulations governing their siting and construction.

In addition to the mass of legislative enactments, the volume contains useful commercial statistics, *e.g.* details of all French tankers, sea, river, and also road and rail; the sale of products such as motor spirit (both grades) and fuel oil for each *departement* of the country, details of main product groups made at each French refinery, and also statistics relevant to consumption, etc., of petroleum products in French overseas territories.

A general table of contents and a good index facilitate use of the book.

The publisher's claim that the volume is essential to those in the oil business can, as far as anyone dealing in or with France is concerned, certainly be endorsed. V. B.

Physical and Azeotropic Data. G. Claxton. London: National Benzole Association, 1958. Pp. 146 + v. 42*s* (postage 1*s* 6*d*).

During the preparation of a new edition of "Motor Benzole, its Production and Use," it was found desirable to tabulate the more important physical properties of the hydrocarbons and sulphur compounds boiling below 200° C. Because of the large number of these, it was decided to publish the collected information in a separate book. Following general information on classification, nomenclature, and so on, data are given of melting point, boiling point at normal pressure, density at 20° C, and a refractive index for the D line of sodium at 20° C for about 1500 hydrocarbons and about 150 sulphur compounds. Where values at the specified temperature are not available, the temperature at which the quoted value was determined is indicated.

Tables of azeotropic data are also given for some 1400 binary, ternary, and quaternary azeotropes. At least one constituent in each azeotrope is selected from 14 compounds

that are main constituents or contaminants in benzoles derived from coal carbonization.

As a handy reference book of authoritative data the book has much to commend it.

1959 SAE Handbook. New York: Society of Automotive Engineers, 1959. Pp. 860.

Since publication of the 1957 edition of the SAE Handbook considerable revision has been made to much of the contents and the whole book has been re-set in a new format. One effect has been to reduce the number of pages by some 25% without in any way impairing its usefulness.

In so far as the petroleum industry is concerned, the data on corresponding ranges in kinematic, Redwood, and Engler viscosities of crankcase oils has been extended. New tables are given for values at 212° F (100° C) for SAE 20, 30, 40, and 50 crankcase oils and for SAE 90, 140, and 250 transmission and axle lubricants. The general information on the latter has also been amended to incorporate the API recommendations on multi-purpose type gear lubricants.

A specification for an extra hydraulic brake fluid (SAE 70R3) covers a fluid of higher boiling point and flash point higher than 70R1. It also gives swelling test procedures for both natural and GR-S rubbers.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren "Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the "Library Catalogue" published by the Institute.

000 HOPE, S. The battle for oil. London, Robert Hale, 1958. 198 p.

020 SOCIETY OF AUTOMOTIVE ENGINEERS. 1959 SAE Handbook. New York, SAE, 1959. 860 p.

040 AMERICAN SOCIETY FOR TESTING MATERIALS. Five-year index to ASTM technical papers and reports, 1951–1955. Philadelphia, ASTM, 1957. 90 p.

040 UNITED STATES. *Bureau of mines.* Bibliography of investment and operating costs for chemical and petroleum plants. July 1954–December 1956. Washington, USBM, 1958. 100 p.

080 BRITISH PETROLEUM CO. LTD. News in pictures 1958. London, BP, 1959.

080 COMPOSITE CATALOG . . . of oil field equipment and services, 1958–59. Houston, Texas, Gulf Publishing Co., 1958. 3 v.

080 GUIDE DU PÉTROLE . . . et de son équipement. Tome: Reglementation. Paris, O. Lesourd, 1959. 703 p.

090 BRITISH STANDARDS INSTITUTION. Adjustable hand reamers with inserted blades. London, BSI, 1959. 7 p. (BS 3088 : 1959).

090 BRITISH STANDARDS INSTITUTION. Pliers, pincers, and nippers. London, BSI, 1959. 64 p. (BS 3087: 1959.)

200 LOVELACE, A. M., RAUSCH, D. A., *and* POSTELNEK, W. Aliphatic fluorine compounds. New York, Reinhold, 1958. 370 p.

210 CLAXTON, G. Physical and azeotropic data. London, NBA, 1958. 146 p.

210 COULSON, E. A., *and* HERINGTON, E. F. G. Laboratory distillation practice. London, Newnes, 1958. 166 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. ASTM standards on gaseous fuels. Philadelphia, ASTM, 1958. 194 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. 1958 book of ASTM standards including tentatives. Part 1: ferrous metals. Philadelphia, ASTM, 1958. 1589 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. 1958 book of ASTM standards including tentatives. Part 3: methods of testing metals. Philadelphia, ASTM, 1958. 962 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. 1958 book of ASTM standards including tentatives. Part 4: cement concrete. Philadelphia, ASTM, 1958. 1422 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. 1958 book of ASTM standards including tentatives. Part 10: textiles. Philadelphia, ASTM, 1958. 1493 p.

720 HALA, EDUARD, *and others.* Vapour–liquid equilibrium . . . translated by G. Standart. London, Pergamon Press, 1958. 402 p.

740 DAVIDSON, R. L. Successful process plant practices, operation, maintenance, and safety. New York, McGraw-Hill, 1958. 302 p.

760 AMERICAN PETROLEUM INSTITUTE. *Division of refining.* Manual on disposal of refinery wastes. Volume II: Waste gases and particulate matter. 5th edition. New York, API, 1957. 68 p.

810 MINISTRY OF POWER. The efficient use of fuel. 2nd edition. London, H.M.S.O., 1958. 888 p.

830 INSTITUTION OF MECHANICAL ENGINEERS. Proceedings of the conference on lubrication and wear, London: 1 October 1957. London, I.M.E., 1958. 911 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

800. Compaction of sediments. J. M. Weller. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 273–310.—An attempt is made to explore the theoretical relations between compaction of sediments and depth of burial. Mud and shale are compacted in several stages that involve: (1) squeezing out of interstitial water until the sedimentary grains come in contact with each other; (2) rearrangement of grains and development of closer packing; (3) soft clay minerals are forced into the interstices between the more resistant minerals; (4) the latter are deformed until all porosity is eliminated. The colloidal properties of clay are very important in this process, whose results appear to be predictable for sediments with different proportions of clay minerals.

Much less compaction is possible in sand and sandstone because initial porosity is much lower. Colloidal effects are negligible. Most compaction appears to result from intergranular solution, but the results are unpredictable, because intergranular cement strengthens structure. No consistent relations exist between porosity and depth of burial.

The consolidation of limestone is not understood. The initial porosity of most calcareous sediments is greater than that of sand, but most limestones show little evidence of compaction. E. N. T.

801. Some open questions regarding petroleum origin. B. T. Brooks. *J. Inst. Petrol.*, 1959, **45**, 42–6.—The carbonium ion theory of the action of acid cat such as natural silicates on hydrocarbons explains a number of known facts about the

origin of petroleum. A number of aspects of the overall problem of petroleum origin requiring further information are discussed. These include, amongst others, the unknown nature of most of the organic matter in recent marine deposits, the mechanism of the chemical changes in fatty oils or acids which are assumed to be the principal original material, the nature of these fatty materials in marine life, and the reason why there are conspicuous differences in the composition of petroleums. A. D. S.

802. Geologic architecture of circum-Pacific. L. G. Weeks. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 350–80.—The circum-Pacific mobile belt is peripheral both to the high-standing, deep-rooted, approximately andesitic composition continental crust and to the broad basaltic crustal plate underlying the Pacific Ocean. It was in similar peripheral zones, now along one continental margin, then along another, that former mobile belts were initiated, developed through several hundred million years each, and were finally stabilized. Throughout geologic history, many additions were made to the margins of the continental crust by this process. Accompanying this build-up of the various continental nuclei, the always stable basaltic ocean crustal plates have, on balance, correspondingly diminished in area and their waters have deepened.

Additions to the lighter continental crust through mobile belts were effected mainly by differential subtraction of the lighter, more silicic, more alkalic constituents from the ultrabasic subcrust. This process left the latter still more basic, and added the subtracted materials to the newly forming continental crust by vulcanism and other extrusives and intrusives. These materials were fed upward along several-hundred-mile-deep earth fractures or zones of disturbance. The position, depths reached, and nature of these great master "fractures" is being revealed by studies of earthquakes and vulcanism, both of which are concentrated today in the circum-Pacific mobile belt. These great master "fractures" are now known to be one of the main, if not the primary controlling feature in the development life of mobile belts. Sediments derived mainly from the older, continental lands, but also from newly-formed, peripheral island arc masses accumulated in geosynclines and, in considerable part, were ultimately metamorphosed or even "granitized" before the diastrophic cycle had run its course.

All stages in the diastrophic-sedimentary cycle of the typical mobile belt are represented in the circum-Pacific architecture. Thus, the various sectors of the circum-Pacific are described against the background of the sequence of stages in the life history of a typical mobile belt. E. N. T.

803. Polarographic determination of iodine. (In Polish.) Z. Przybylski. *Nafta* (*Krakow*), 1958, **14**, 73–5.—Since high content of iodine is prevalent in sea creatures and these are thought to be the source of crude petroleum, the Polish Institute of Petroleum has devised a quick, cheap, and accurate method for its determination. Polarography gives a 0·7 V wave for I′, but it suffers from interference from Br′ and Cl′. On oxidn iodates give results quite distinct from many common ions and they are stable to Na_2SO_3 at pH above 7. The wave is six times as high as for I′ when dropping Hg electrode is employed. As a result of investigations, various calibration curves have been drawn and a list of non-interfering ions at their max concn is given. M. S.

804. Humble hits five pays in King Ranch. F. J. Gardner. *Oil Gas J.*, 2.3.59, **57** (10), 165.—The N Alazan field, Kleberg County, Texas, was discovered in Dec 1958 and the three wells completed have shown that it may prove to be a major field. Five Frio sand pays have been found. These range in depth to *ca* 7500 ft, and max production on test was from the H-21, in 6 King Ranch Alazan, which flowed 281 bd of 39·4° oil from 7220–7230 ft. These discoveries emphasize the need for deeper exploration in S Texas in the sparsely drilled area where possibilities for multi-pay Frio fields are good. Geologically it is near the centre of the SW salt basin. C. A. F.

805. Are we missing carbonate pools? J. T. Bado. *Oil Gas J.*, 16.2.59, **57** (8), 208.—*Ca* 50% of the world's oil production comes from carbonate reservoirs, and development is complicated by the difficulty of identifying stratigraphic and lithological changes. This is the case in the Mississippian Chester in Alfalfa County, Oklahoma, where a few fields have been discovered in recent years. Anticlines have been found productive, but it is thought that porosity–permeability variations can provide traps in the Chester; palæogeographical studies indicate an E–W trend of porosity. The general geology and structure of the area are briefly outlined. Secondary recovery operations in the Chester are not thought to be profitable because of generally erratic porosity and permeability variations. Other pays sought in the area are Oswego limestone (structural traps), Lower Pennsylvanian sands, Simpson–Wilcox, and Arbuckle (untested). C. A. F.

806. In Southern Oklahoma the Simpson rewards oil hunters. P. B. Bike. *Oil Gas J.*, 23.2.59, **57** (9), 184.—Exploration for Simpson production in S Oklahoma has been very successful since the discovery of the Cumberland field in 1940. At the end of 1958 this field had a cumulative production of 54,557,000 brl and estimated recoverable reserves of 20 million brl. Ten new Simpson fields were found in the area in 1958, and there are good prospects for 1959. Pays are deep, but new techniques are combating high pressures and temp problems. Future Ordovician wells will probably range from *ca* 15,000 to 17,000 ft in depth. Main emphasis is at present on structural trends, but stratigraphic possibilities will be evaluated. C. A. F.

807. Where's the oil in Kansas? D. F. Merriam and E. D. Goebel. *Oil Gas J.*, 9.3.59, **57** (11), 212.—The post-Mississippian structural provinces are thought to be of main importance in controlling oil accumulations in Kansas. The oil possibilities in each main producing province are evaluated. In the Forest City basin most of the production comes from Pennsylvanian sands, including shoestrings, and many of the fields are now being repressured. There is also production from the Mississippian, Siluro-Devonian, and Ordovician. In the Cherokee basin there is also production from Permian, Pennsylvanian, and older rocks, and fields on the Nemaha anticline, Salina basin, Cambridge Arch, Sedgwick basin, Pratt anticline, Central Kansas Uplift, and the Hugoton Embayment also produce from pays of various ages. *Ca* 28% of the fields in the state produce from two or more pays, usually the Pennsylvanian and Arbuckle, and *ca* 4% produce from three zones.

Recent developments have revived interest in NW Kansas, where Pennsylvanian production has been found at Llanos, and there have been Mississippian finds with large new fields in the Sedgwick basin.

At the end of 1956 production of the state was from the Pennsylvanian and 57·3% from the Cambro-Ordovician. Recent trends indicate that Mississippian production will become more significant. C. A. F.

808. Investigations in radioactivity-dating of sediments. S. S. Goldich *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 654–62.—Two samples of glauconite from the Upper Cambrian Franconia formation in Goodhue County, Minnesota, give an average K-A age of 440 m.y. Illite from the Siyeh limestone, Belt series, Glacier Park, Montana, is dated at 740 m.y. by K-A and 780 m.y. by Rb–Sr techniques. Pipestone from the Sioux quartzite at Pipestone, Minnesota, gives a K-A age of 1·20 b.y., and the time of deposition of the Sioux formation is

placed in the early Middle Keweenawan or Lower Keweenawan. Geologic history of sediments subsequent to deposition is most important in attempting to date the time of deposition. X-ray crystallographic studies coupled with radioactivity-dating should lead to a better understanding of the history of sediments and of the changes that commonly are attributed to diagenesis. E. N. T.

809. Revision of Big Snowy group in Central Montana. L. S. Gardner. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 329–49.—The 1500 ft or so of Carboniferous rocks above the Madison group in the Big Snowy Mountains of Central Montana are here divided into six lithically and faunally intergrading formations. They are believed to represent an almost continuous depositional sequence of mainly shallow-water sediments that formed near the centre of an episodically subsiding marine basin during Late Mississippian and Early Pennsylvanian time. Marginal overlaps and locally discordant relations, attributable to intervals of accelerated subsidence or shoaling, are likely to be prevalent along the now mainly buried shelf-edges of this irregular basin.

As a name for the entire intergrading sequence, the Big Snowy group of Scott is expanded and redefined to include, in ascending order, not only the Kibbey sandstone, Otter formation, and Heath formation of his original report, but also three overlying formations—the newly named Cameron Creek formation, the Alaska Bench limestone, and the newly named Devils Pocket formation. E. N. T.

810. Palæozoic prospects look good in Eastern Nevada. E. G. Johnson. *Oil Gas J.*, 9.2.59, **57** (7), 148.—Exploration in E Nevada is continuing, in spite of generally unsuccessful drilling. Oil was found in Nye County in 1954 with production from Tertiary pyroclastics, but subsequent tests on seismic structures in the intermontane basins were disappointing. The search is concentrated on defining regional structure and stratigraphy in the Great Basin, where Palæozoic structures are exposed. Seismic work has been hampered by the masking effect of overburden covering *ca* 60% of the area. The structural and stratigraphic history of the area is outlined. There is an almost complete marine Palæozoic sequence averaging 600 ft thick above the Cambrian. Potential source and reservoir rocks exist and numerous structures and possibilities for stratigraphic traps occur. Main objectives are found at fairly shallow depths in many areas, and it is considered that the oil possibilities of the area are very good. C. A. F.

811. Tertiary on the wing in Wyoming basin. P. B. Bike. *Oil Gas J.*, 9.3.59, **57** (11), 211.—Until 1958 commercial production from the Tertiary in Wyoming had been found only in the Green River basin and the Rock Springs Uplift, but there have been recent Tertiary discoveries in the Wind River basin. These occur on the N flank of the basin, where the geology is highly complex and only 25% of the area has been tested. Two recent finds are Lost Cabin and W Lignite and production comes from the Eocene Wind River. The Tertiary oil is thought to have migrated upwards from a Cretaceous source as the beds are non-marine. C. A. F.

812. New green on oil map chases Canada's blues. J. C. McCaslin. *Oil Gas J.*, 16.2.59, **57** (8), 205.—Two new reservoirs in W Canada have proved to be prolific and are being actively developed. They are the Middle Devonian Beaver Hill Lake reef limestone and a Trias pay. The former is producing in the Swan Hills region near the Peace River in Alberta, where 20 wells are on production and, until the discovery of Virginia Hills in 1957, it had not been found productive in Canada. It is now the most important exploration target in Canada. In NE British Columbia there is Trias production in the Beatton River and Milligan Creek fields, and reserves estimates for the area are as high as 1 million brl/well. C. A. F.

813. First-order nappe in Canadian Rockies. G. G. L. Henderson and C. D. A. Dahlstrom. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 641–53.—Alpine geologists have recognized two types of nappes, first-order and second-order. First-order nappes are large overturned, generally recumbent folds wherein the middle part of the overturned limb (or "fore limb") is replaced by a thrust.

The purpose of this paper is to describe a first-order nappe in the vicinity of Fernie in the SE corner of British Columbia. Field evidence strongly suggests that thrust faulting began and ended during the latter stages of folding. E. N. T.

814. Lower Cretaceous of Southern Alberta and adjoining areas. R. P. Glaister. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 590–640.—The total stratigraphic interval studied in S Alberta and N Montana includes all of the Lower Cretaceous strata between the sub-Cretaceous unconformity and the base of the "Fish Scale" sandstone, which occurs near the Lower Cretaceous–Upper Cretaceous boundary. Abrupt facies changes in the Lower Cretaceous sediments in W Alberta necessitate a different nomenclature in the Foothills area than in the Plains area.

Outcrop is limited to the disturbed belt in W. Alberta and Montana and to the S margin of the area along the Missouri River. In the present study 140 control points gave an average control density of one point to every 900 sq miles. Well cuttings and/or cores from 32 of the 122 subsurface control points were personally examined by the writer. E. N. T.

815. Triassic stratigraphy, Peace River area, Alberta and British Columbia, Canada. A. D. Hunt and J. D. Ratcliffe. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 563–89.—During the past five years, through the discovery of significant accumulations of oil and gas, the Triassic formations of the Peace River area have assumed a position of economic importance. The Triassic has been sub-divided into six formations, Toad–Grayling, Liard, Halfway, Charlie Lake, Baldonnel, and Pardonet, using, wherever possible, the names assigned by others working in the area. Each formation has been described and type sections designated for the Halfway, Charlie Lake, and Baldonnel formations. Isopachous maps and, for most of the formations, lithofacies maps have been drawn to show the lateral variations within these formations. Correlation has been established with the outcrop sections of the adjacent Rocky Mountain foothills, together with limited age determinations. The depositional history is reviewed, including a discussion of the evaporitic cycle of the Upper Triassic. E. N. T.

816. Ghawar oilfield, Saudi Arabia. Arabian American Oil Company Staff. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 434–54.—Ghawar field is located *ca* 50 miles inland from the W shore of the Persian Gulf, in Hasa Province, Saudi Arabia.

The field was discovered in 1948 by a wildcat well at Ain Dar. Other wildcats, Haradh (1949), 'Uthmaniyah (1951), and Shedgum (1952) proved to be on subsidiary closures of the same great anticline, and parts of the same oilfield. Oil-finding has been primarily through structure drilling, although surface mapping furnished initial clues and gravity mapping proved helpful.

The oilfield is a structural accumulation along at least 140 miles of the N–S-trending En Nala anticlinal axis. The fold is simple in the S, develops two low marginal crestal closures in the centre, and is subdivided into two adjacent anticlines in the N. Seven crestal closures have been found, but oil appears to be continuous from Ain Dar to Haradh.

Ghawar oil is Upper Jurassic, occurring in the shallow-water carbonate sediments of the Upper Jubaila and Lower Arab formations. It is confined above by the lowest of the three

anhydrite members of the Arab formation. Only minor shows of oil have been found in higher parts of the Arab. The most prolific production is derived from calcarenites in which much original pore space survives. Other rocks making up the reservoir are fine-grained limestone, calcarenitic limestone, dolomitic limestone, and dolomite. Partial dolomitization, usually porphyroblastic, is extensive. E. N. T.

817. Productive and prospective petroliferous zones within tectonic framework of Japan and adjacent areas. G. F. Kaufmann. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 381–96.—The festoons of island arcs marked by the Nampo Shoto, N Japan, the Kuriles, Kamchatka, and the Aleutian Islands are the most recent additions to the NE part of the Asian Continent and have resulted from Late Mesozoic and Tertiary orogenies. Japan and Kamchatka are polycyclic orogenic mountain arcs and were part of older festoons of island and mountain arcs extending from Kamchatka through Formosa and the Philippines. Early orogenic movements can be traced in Japan in the late Devonian, Carboniferous, and Middle Permian. The present forms and positions of the Japanese Islands were probably defined during Early Mesozoic orogenies.

In narrow, coastal areas of NW Honshu, W Hokkaido, and SW Sakhalin, small production of oil and gas is obtained from Upper Tertiary formations on folded and faulted structures fringing the mobile side of the Japan Sea sedimentary basin. In NE Sakhalin, more substantial oil production is obtained from Tertiary beds where structural and stratigraphic conditions suggest that the accumulations occur on the present, more or less stable side of the Okhotsk Sea idiogeosynclinal basin.

New, and perhaps important, oil discoveries can be expected from structural folds located off the NW coast of Honshu and Hokkaido, and perhaps off the SW coast of Sakhalin.

E. N. T.

818. Oil exploration in Australia. P. E. Playford and M. H. Johnstone. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 397–433.—In the past five years oil exploration in Australia has been greatly accelerated, but no commercial fields have been discovered. Exploration has been most intense in W Australia.

Pre-Cambrian sedimentary, metamorphic, and intrusive rocks cover a large part of Australia. During the Palæozoic, a huge vol of sediments accumulated in the great Tasman geosyncline, along the E side of the present Australian continent. The pre-Permian sediments of the Tasman geosyncline are generally regarded as basement in oil exploration, as they are metamorphosed and intensely deformed.

In the central and W parts of the continent the pre-Cambrian shield is overlapped by a series of basins containing Cambrian and younger sediments. In E Australia similar basins overlie basement rocks of the Tasman geosyncline, and contain Permian and younger sediments. These basins show relatively mild deformation, and several are regarded as prospective in oil exploration. The Carnarvon and Canning basins in W Australia are believed to contain thicker prospective sedimentary sequences, and consequently are likely to have better oil prospects, than the other sedimentary basins of Australia. For this reason they have recently received most attention in oil exploration.

The only bore drilled in Australia which has produced a significant flow of oil is West Australian Petroleum's Rough Range No. 1 in the Carnarvon basin. E. N. T.

819. Sedimentary belts in lagoon of Kapingamarangi Atoll. E. D. McKee *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 501–62.—Kapingamarangi Atoll, southernmost of the Caroline group of islands in the W Pacific Ocean, was the subject of a geological investigation during three summer months of 1954. This atoll, situated in an isolated position approx 1° north of the Equator, consists of a circular peripheral reef surrounding a lagoon and containing 33 small islands along its E rim.

The geology of the islands, petrology of the sediments and sedimentary rocks, variation of soils, development of phosphorite, nature of ground water, and other general features have been described by McKee (1958). The present study is designed to supplement this general survey by summarizing results of a detailed analysis of sediments of the lagoon and by describing their relations to the rigid reef framework.

E. N. T.

820. Some problems of Carpathian foothills and borderlands tectonics. (In Polish.) R. Ney. *Nafta (Krakow)*, 1958, **14**, 59–65.—Some regions of the Carpathians are still not very well known, and among them is the so-called "Przemysl sigmoid." It contains formations unknown in the Central and W Carpathians. Politically the area now is split between Poland and U.S.S.R. (W Ukraine). Geologists from both sides of the border have co-operated. Work done 50 years ago in the area is reviewed, and it appears to have been correct, since more recent discoveries identify the Przemysl depression with a local loop of the Carpathians in this region. Seismic work in this area points to a subsidence of the strata 5000 m below the mountains. This, however, does not explain the "sigmoid." The foothills, which include parts of two origins, are described in detail: the inner, Miocene formation shows signs of invertion and is salt-bearing; the outer, which is known as a synclinorium, is an autochton of older origin. The differences are clearly illustrated in four diagrams, and so is the relationship between these two and the Carpathians. The forming mountains have shifted a "piece" of Miocene using salt-bearing formations as lubricant. In general, however, the Carpathians overlay Miocene, and perhaps if they were drilled through the latter could be reached. There is also the possibility of encountering a broken-off part of Miocene embedded in the younger rocks. M. S.

821. Thrust faults and ruptured folds in Rumanian oilfields. W. M. Small. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (2), 434–54.—Overthrust faults and ruptured, asymmetrical salt folds overriding one flank occur in the Rumanian oilfields, where deep drilling gives control on subsurface conditions.

The folding developed very gradually during early Pliocene along axial lines already existing in the Miocene and older Tertiary rocks; thus accumulation of oil and gas in the Lower Pliocene (Meotian) and Middle Pliocene (Dacian) must have taken place before the large-scale folding and faulting (Wallachian) of the last stage (Levantine) with vertical movements of several thousand feet. Salt and salt breccia were squeezed into or through some of the folds or rupture lines, for the weight of the Pliocene was enough to bring the salt masses to a plastic state.

With 10,000–15,000 ft of sediments, most of which were unconsolidated, lying on a sloping foundation of the Carpathian foreland, it is easy to visualize the long strike folds pressing forward and down the slope as the uplift of the Carpathians reached its climax. Salt and salt breccia, along with fluids and gases entrained along lines of movement, served as lubricants.

There is little indication of movement of reservoir contents far from the original places of accumulation. Where faulting has afforded communication between Meotian paraffinic and Dacian non-paraffinic oil-bearing sands, crudes of mixed base are found in the latter. E. N. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

822. Geochemical aspects of petroleum migration in Pembina, Redwater, Joffre, and Lloydminster oilfields of Alberta and Saskatchewan, Canada. G. W. Hodgson and B. L. Baker. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 311–28.—The

chemical character of the crude oils produced throughout four major fields and several minor fields in W Canada has been studied. The variations in nickel and vanadium content appear systematic and are undoubtedly a key to the accumulation history of the oils. The metal variations run parallel for the most part to variations in sulphur, resins, and asphaltene content of the oil as well as to the gravity, and are apparently sensitive indicators of crude oil alteration. The Pembina field is the most interesting because the magnitude of the variations from point to point in the field is very large—about tenfold for the metals. Much smaller variations are noted for the other fields, and this may be a result of the smaller sizes of those fields. If the data are interpreted in the light of probable adsorption alteration during accumulation and probable source conditions, the Pembina–Cardium oil apparently accumulated in the Cardium sands in a direction away from the present updip edge at the NE; the Redwater oil, from downdip towards the S; the Viking Joffre oil, from downdip at the SW; and the Lloydminster oil pools, from very local source rocks. E. N. T.

823. Microbiological investigations in the Inowroclaw region. (In Polish.) A. Luchter. *Bull. Polish Inst. Petrol.*, 1958, **8**, 4 (suppl. to *Nafta* (*Krakow*), 1958, **14**).—The Geochemical Establishment of the Polish Institute of Petroleum has tried out the microbiological method over an assigned area. 55 stations were in operation, and samples of soil from a depth of 2 m were taken. Each was tested in duplicate, with and without additional hydrocarbon gas feed. Methane-consuming bacteria are not in themselves a proof of existence of hydrocarbon deposits, propane-consuming bacteria are more conclusive. The former were found in 12 cases and the latter in 18 cases. Cultivating bacteria from soil samples is more laborious than planting cultures in order to investigate their survival in the gases rising from the soil, and this second method is therefore recommended. M. S.

DRILLING

824. Comparing the rotary with potential drilling methods. R. Simon. *J. Petrol. Tech.*, Nov 1958, **10** (11), 28–30.—The rate of penetration of any mechanical drilling machine is essentially directly proportional to the mechanical power developed in the rock per unit area of hole and inversely proportional to the drilling strength. Only a fraction of the power capacity of the rotary table can be applied to the rock when drilling in the stronger rocks at the max practical weight on the bit and max practical rate of rotation. This is one of the main limitations of rotary drilling.

The turbo-drill, by rotating the bit faster, applies more mechanical power to the rock. Vibratory and sonic drilling involves rotation and vibration at a frequency of the order of 100 cps. There is a down-hole percussion drill using 10–40 cps and motivated by the mud. Bit footages range half to twice those for rotary drilling; rates of penetration range from under two times in weak rocks to nearly ten times in strong rocks of the rates for rotary drilling. The drilling cost for the new methods would probably be less than for rotary in wells not too deep; at greater depths, depending on the rocks, improvement may be marginal to negative. G. D. H.

825. Fewer wells drilled by rotary method. Anon. *World Oil*, 15.2.59, **148** (3), 117.—13·5% of wells in the U.S.A. in 1958 were drilled by cable-tool methods, compared with 13·0% in 1957. 41,806 wells were drilled by rotary rigs in 1958, the smallest number of rotary completions since 1953. 6525 wells were drilled with cable tools in 1958. Tables show these drilling trends. C. A. F.

826. When to cut the drilling line. C. M. Zerr. *World Oil*, March 1959, **148** (4), 103.—There is a need for a field procedure for cutting off a rotary drilling line. Various hazards can affect rope service, such as line whipping, bad winding on the drum, excessive impact loads at pick-up, and overloading. Martensite formed on the surface of the wire by combinations of creep, loading, and other causes is also a source of early wire failure. Regular visual inspections are necessary, and it has been found that there is an optimum ratio of work done to length of cut-off; this can be determined by experience for a particular rig. Field examples are given, and five procedures are recommended to extend rope life: (1) protect rope from weather; (2) prevent careless handling in storage; (3) install rope on properly designed rack; (4) string up properly; and (5) use well-designed hold-down sheaves. C. A. F.

827. Solid injector for air and gas drilling. B. V. Randall, J. L. Lummus, and R. P. Vincent. *Petrol. Engr*, Dec. 1958, **30** (13), B108.—With the introduction of anti-balling materials, such as stearates of zinc or calcium, to facilitate the handling of small quantities of water while drilling with air or gas, the problem of injecting solid material into a high pressure gas supply line became evident. To accomplish this objective, a special pump has been developed which permits controlled, continuous injection of stearates and other powders into air stream against pressures up to 750 psi. This consists basically of a prime mover which drives a pair of sprockets, forming a part of a conveyor-chain assembly. The sprockets are designed to accommodate a chain made of a series of equally spaced pistons and the chain–piston combination serves as a conveyor. As the sprockets rotate, the anti-balling material is picked up between the pistons and carried through the inductor tube into the flow line. The detailed mode of operation is described in the paper. M. F. M.

828. Water can be controlled in air and gas drilling. Pt 2. Sealing materials used in the laboratories and field operations are proving successful. W. F. Hower *et al.* *World Oil*, March 1959, **148** (4), 111.—Two basic materials have proved successful in sealing off encroaching formation water in air and gas drilling. These are a polymeric water gel (PWG), a true solution which sets to form a stiff gel; and a new type of resin which can be used in low visc form or combined with inert solids to give a bulking effect and to control fluid lost from the slurry to the formation. Field applications of these materials are discussed; research is continuing to improve both products and emplacement techniques. C. A. F.

829. Some faults of drilling rock-bits. (In Polish.) M. Dubowicki and J. Rys. *Nafta* (*Krakow*), 1958, **14**, 38–43.—Of the trio "source of power–connexion–tool," the bit has the shortest life. Within it, bearings are the weakest point. Teeth which are under greatest stress are well adapted for it by virtue of modern steels available, ranging from 0·16–0·24 C, 0·9–1·2 Mn, 0·17–0·37 Si, 0·9–1·2 Cr, 0·2–0·3% Mo. Bearings are made from steels with C 1·0–1·1, Mn 0·2–0·4, Si 0·15–0·35, Cr 0·4–0·7, P $\leq$ 0·027, S $\leq$ 0·02, Ni $\leq$ 0·3, Cu $\leq$ 0·25% (Ni + Cu $\leq$ 0·5%). Carbonization and hardening processes employed are described. When analyses of 30 prematurely broken bits were made failures discovered were due to incorrect metallurgical, shaping, thermal, and machining treatments, also from wrong working conditions, which are outside the scope of this inquiry. Oxides, sulphides, and silicates have been found in the shape of intruding veins. Shaping, pressing, and other hot working processes are designed to produce longitudinal grain, "fibre-like" formation parallel to the axis of the bit which is to be formed from the piece. This is often not so. Various faults in hardening and other heat processes can be seen from microphotographs. Limits of thickness of carbonized layer are very stringent. Cracks can become incipient during these operations. Machining may create weaknesses where there is a sudden change of dia, such as is the case with hubs and axles. In conclusion, the authors

hope that by classifying the causes of failures they have pointed out that some of them should be cured early on in the manufacture and others in later stages. 20 microphotographs in text. M. S.

830. Driving shafts with "Cardan" flexible transmission joints in drilling equipment. (In Polish.) R. Wolwowicz. *Nafta (Krakow)*, 1958, **14**, 65–9.—The idea of replacing chain drive for drilling equipment with shafts is gaining support in Poland, and drilling rig OP 1200 has proved that it is satisfactory. Basic calculations are given. M. S.

831. Well-logging attempts by "gamma-gamma" method. (In Polish.). J. Szymanski and B. Wyzlinski. *Bull. Polish Inst. Petrol.*, 1958, **8**, 3–4 (suppl. to *Nafta (Krakow)*, 1958, **14**). —This method means measuring dispersed gamma radiation in rocks illuminated by a beam of gamma radiation. The intensity of dispersed radiation is $A\rho^2 \frac{e^{-\frac{\rho R}{14}}}{R}$ *i.e.* const (dens)^2 exp (-dens dist/14)/dist. Lab work was done in 1955 and field work in 1956; six strata were tested for calibration purposes. 10-mC source and four Geiger counters were used. In spite of teething troubles, the method proved itself to be generally useful. M. S.

832. Will drilling increase in Western Anadarko border area? R. R. Wheeler. *World Oil*, March 1959, **148** (4), 94.—Oil possibilities in the W Anadarko basin border area which covers several thousand square miles in New Mexico, Colorado, Texas, Oklahoma, and Kansas are described. Potential reservoir formations in this region wedge out above the pre-Cambrian basin in a belt which is strongly folded and faulted. Encouraging shows have been found in test wells, and it is thought that local accumulations may be structural rather than the stratigraphic type found to the E. Pays should occur at fairly shallow depths, and potential reservoir sections are thicker than in the fields to the E. Objectives are early Pennsylvanian Morrow sands, which may be lenticular, and Mississippian and Arbuckle dolomitic limestones. Scattered wells have shown that these rocks have general permeability and some have tested gas-cut mud and salt water.

C. A. F.

PRODUCTION

833. Recent developments in well testing. D. A. Schmeckle. *Canad. Min. metall. Bull.*, 1959, **52**, 19–25.—Equipment for separating and metering oil, water, and gas in transfer from well-head to pipeline is described. The relative merits of the different types of portable and fixed equipment are discussed. Used with recording and data transmitting equipment, the metering techniques described allow of continuous automatic well testing. G. B.

834. Here's how to pump a triple completion. D. N. Newby and J. A. St. John. *World Oil*, 1959, **148** (4), 91.—The first triple pumping well has recently been completed in the Rocker A field, Garza County, Texas, and the method of operation is described with diagrams. Three insert pumps are run in tandem on a single string of hollow sucker rods, a string of 1-inch production tubing being run and seated in a cross-over shoe which is independent of the main 2-inch tubing string. The 1-inch tubing is the conduit for one of the zones. Two packers are used to separate the three producing zones, and all equipment was handled through 5½-inch casing. All the pumps are actuated by a single jack at the surface.

The producing zones are the San Andres, 2437–2478 ft (perforated), and Glorieta, 3013–3048 ft (perforated), and Clearfork, 3195–3226 ft (open hole completion). C. A. F.

835. Unique programme combats external tubing corrosion in California. P. W. Hill and H. J. Kipps. *World Oil*, March 1959, **148** (4), 98.—A costly corrosion problem in the annulus of directionally-drilled wells in the Redondo Beach area, California, is being combated by: (1) changing completion methods; (2) plastic coating the external surface of tubing strings; and (3) injecting inhibitors, using a chemical wash oil-injection system which is automatically controlled and protects uncoated well equipment. Details of the procedures are given. In a high-angle hole it was found that much mud was bypassed during fluid change over on completion and that this caused corrosion. New completion techniques now enable the mud to be displaced, using oil base mud and crude oil as replacing fluids. The plastic coating was a catalysed epoxy phenolic resin and was applied in two 4-ml coats. The inhibitor was an oil soluble, polar organic material which wets the metal surface with crude oil. 1–4 bd of crude oil are used to flush the inhibitor into the annulus. C. A. F.

836. Importance of reliable data in gas-condensate recovery calculations. R. F. Hinds. *J. Petrol. Tech.*, Nov 1958, **10** (11), 60–2.—The results of 44 lab depletion studies on actual gas-condensate fluids showed a general trend of increase in ultimate recovery as the initial producing ratio increases, but there is considerable variation at a given producing ratio. As the initial producing ratio rises, the ratio of light to heavy hydrocarbons increases in the well stream, and this imposes greater volatility on the heavy components. For similar producing ratios and similar reservoir temp the reservoir fluid with the more volatile heptanes and heavier, or higher, stock-tank API gravity gives the greater recovery during depletion.

Lab studies on a given gas-condensate reservoir fluid at 120°, 240°, and 300° F, with abandonment at 500 psig gave stocktank liq recoveries of 16·1, 36·2, and 51·5%, respectively, of the initial liq.

Eight deviation factors ranged from 1·275 at 244° F and 7700 psig to 2·038 at 205° F and 11,000 psig.

The wide variations of the factors considered emphasizes the need for reliable data in calculating the recovery from a given gas-condensate system. G. D. H.

837. Gas injection in Eastern Venezuela field increases oil recovery. W. R. Vowel. *J. Petrol. Tech.*, Nov 1958, **10** (11), 31–3.—The "F-7" is the main producing sand at West Guara. It had a small initial gas cap. The porosity is 25–35% and the permeability 1–20 D. There was early evidence of gravity segregation, and it was estimated that primary production would give 59% of the 84,710,000 brl of oil estimated to be in place. Gas injection began in 1948, four years after the discovery. Four of the 58 producers were converted to gas injection, and to June 1958, 41,876,000 Mcf of gas had been injected. 70·5% recovery is estimated as a result of pressure maintenance, and it was calculated that the secondary gas cap would have 15% of oil and the water-invaded zone 40%. Gas injection has allowed production without artificial lift, and with a minimum number of wells. G. D. H.

838. Limitations on pressure prediction for water-drive reservoirs. L. H. Simons and H. H. Spain. *J. Petrol. Tech.*, Oct 1958, **10** (10), 51–3.—Pressure predictions for water-drive fields are especially likely to be subject to error. The predictions for five such fields, based on a few years' production behaviour, have been compared with subsequent performance. Where errors were found attempts were made to find the causes. Errors in pressure, production, or geological data may be involved. The early pressure performance provides information only on the part of the aquifer near the field. It may be necessary to give alternative predictions, one being based on the smallest aquifer adequate to describe past performance, and the other on the largest aquifer considered possible.

Forecasts of absolute pressures are less certain than forecasts of relative pressure behaviour for different producing rates. G. D. H.

839. Oil production by underground combustion. (In Dutch.) H. J. Tadema. *Ingenieur, 's Grav.*, 6.2.59, **71** (6), M1–7.—By heating the oil-bearing formation a larger percentage of the crude may be recovered than is usually possible. Heating can be carried out economically by underground combustion of part of the oil. The reaction has to be maintained by injection of air. Lab experiments have shown that by interaction of fluid flow, chemical reaction, and heat transfer the oil can be very effectively produced from a formation. Application in the field requires method of ignition and data on oil and gas flow patterns between the wells. Field experiments have demonstrated that oil can be produced by underground combustion. 6 figs, 16 refs. (Author's abstract.)

840. Effect of applied pressure on the conductivity, porosity, and permeability of sandstones. D. O. Wyble. *J. Petrol. Tech.*, Nov 1958, **10** (11), 57–9.—Radial pressures up to 5000 psi were applied to Neoprene-sleeved cylindrical samples of Bradford, Weir, and Kirwood sandstones cut parallel and perpendicular to the bedding planes. The axial pressure was atmospheric. The porosity, permeability, and conductivity of the samples were measured under these conditions, and all were found to decrease as the radial pressure was increased to *ca* 3500 psi. Above this pressure the reliability of the data is doubtful. The cementation exponent in the Archie equation increased with pressure.

The flattening of the curves at 3500–4500 psi may be linked with the max burial that the rocks have suffered.

G. D. H.

841. Field results of South Belridge thermal recovery experiment. C. F. Gates and H. J. Ramey. *J. Petrol. Tech.*, Oct 1958, **10** (10), AIMME Tech Paper No. 8032, 236–44.—The test was on a single 2·5-acre five-spot pattern of the Tulare at a depth of 700 ft. The sand was 30 ft thick, dipped at 3°, and contained material ranging from very fine to pebbles. The average oil content was 60%, with 37% water. The oil gravity was 12·9° API, and the visc was 2700 cP at 87° F.

Air injection began in March 1956 at up to 700 Mcf/day. Prior to this wells gave 5 bd of oil. Oxygen reacted with the crude, causing heating, and in June 1956 there was spontaneous ignition giving a temp over 1000° F at the well bore.

Oil producing rates rose after ignition, averaging seven times the previous rates. The recovery was *ca* 51% of the initial oil. The burning front moved 400 ft from the injection well, 6·3 acres being swept by the burning front, which moved at 0·3–4 ft/day. The burned interval was generally less than half the total interval. Oxygen was not observed in gas produced from wells ahead of the burning front. Burning resumed satisfactorily after a 3-day shut-down of air injection.

Well failures occurred due to high temp and corrosion. However, conventional practices were used for workover. Most of the oil production came after the front reached the producing wells. A gas leak occurred. Hence the cumulative ratio of injected air to produced oil, 19 Mcf/brl, may be high. G. D. H.

842. Flooding of gas cap in Norfolk Garr sand unit. H. A. Nelson. *J. Petrol. Tech.*, Oct 1958, **10** (10), 14–17.—Ten gas wells were completed in the W Norfolk field in 1927–30, and then oil wells were drilled in 1949–52. Primary production of 870,000 brl of oil was obtained from 870 acres, of which 225 acres was gas cap. The wells had a shaly sand section of the Peru exposed at the top of the good sand. They were shot with nitroglycerin. The gas cap was depleted extensively before oil was found.

Pilot five-spot water floods began in 1953, and after 15 months oil output improved. The flood was expanded, and in 1957 there were 27 input wells and 43 producers. Water was obtained from shallow wells on the banks of the Cimarron river. Injection into the gas cap began in 1955, $4{\cdot}5 \times 10^6$ brl being needed for fill up and giving a pressure of 700 psi. Breakthrough to the first line of producers occurred and then the flood spread along the strike. To Feb 1958 total water injection was 10,154,000 brl, cumulative water production 1,696,000 brl, with the oil extraction 773,000 brl due to flood and 227,200 brl classed as primary.

An enforced shut-down seems to have damaged the flood operations. G. D. H.

843. Improved wireline cementer developed to cope with water shut-off and channelling problems. G. E. Briggs and W. L. Porter. *J. Petrol. Tech.*, Nov 1958, **10** (11), 17–20.—The wireline cementer employs a propellant burned to build up pressure, which on attaining a suitable value ruptures the cement retainer disk and displaces the cement slurry from the tool into the formation. One to four cement containers can be used, each being 10 ft long and holding 8·5 or 10·2 gal of cement. The propellant is ignited electrically. The pressure build-up sets the hydraulic anchor and the packer, which in the new device is cup-type, and has held pressures of 10,000 psi without leakage. The pressure release mechanism needed to free the cementer involves a pull shearing a brass pin.

Surface tests were carried out, and field tests, mainly water shut-offs, have proved successful. G. D. H.

844. Application of decline curves to gravity-drainage reservoirs in the stripper stage. H. C. Lefkovits and C. S. Matthews. *J. Petrol. Tech.*, Nov 1958, **10** (11), AIMME Tech Paper No. 8037, 275–80.—It has been shown that wells with a free surface in homogeneous gravity drainage reservoirs have a hyperbolic decline with index $n = 2$, and $q/q_i = 1/(1 + \gamma t)^2$, q_i being the rate at zero time and q the rate at time t. Assuming that nearly all the potential available is due to gravity head wells with no free surface, layered reservoirs and the combined behaviour of two wells with different skin effects are considered.

Lease production curves for gravity-drainage curves in the stripper stage were fitted with the general hyperbolic decline equation, n being found by statistical methods. The equation was found to be reliable for extrapolation up to at least 25 years. The results for this period were reasonably accurate when based on 5–7 years' life.

Values of n less than unity were found. This may be due to production from two or more layers of different permeability and thickness, or with different skin effects. As the more permeable layers are exhausted n rises in value. G. D. H.

845. Flooding of semi-depleted solution gas reservoir in Fullerton field. W. E. Nolan and R. M. Williams. *J. Petrol. Tech.*, Oct 1958, **10** (10), 17–20.—The Fullerton Clearfork field produces from a 250–500-ft section of massive heterogeneous dolomite at depths of 6700 ft. Porosity is intercrystalline, vugular, and fracture. The virgin pressure was 2980 psi, and the saturation pressure 2370 psi. In 1954 gas injection began on a 24,040-acre unit, and now 28×10^9 cu ft has been injected. A pilot water flood was started in 1956 using six injection wells on a double five-spot pattern. To March 1958 the injection was 3,215,924 brl. Attempts have been made to adjust injection to the indicated porosity to give even advance. Decreases in gas/oil ratios began after 4 months, and artificial lift had to be installed to keep the wells pumped off. Increased production was noted in under a year, and water breakthrough in under two years.

Prior to the water flood 23 wells involved gave 12,648 brl of oil/month, with a gas/oil ratio of 4993 and 242 brl of water/

month; the corresponding figures for Feb 1958 were 30,730 brl of oil, a gas/oil ratio of 1520, and 9002 brl of water.

It has been concluded from the pilot flood data that the flooding is economic. G. D. H.

846. Improving miscible displacement by gas–water injection. B. H. Caudle and A. B. Dyes. *J. Petrol. Tech.*, Nov 1958, **10** (11), AIMME Tech Paper No. 8038, 281–4.—Miscible displacement recovers all the oil in the area contacted by injected fluid, but water or immiscible gas leaves substantial amounts of oil behind. Gas-driven miscible displacement, because of poor mobility ratios, has a pattern efficiency inferior to that of water flooding, and this may offset the other favourable features. A decrease of mobility behind the flooding front can increase the sweep efficiency of the miscible displacement process. This decreased mobility can be obtained by injecting water with the gas which drives the miscible slug.

Lab model studies indicate a sweep-out efficiency of *ca* 60% for gas as the driving medium and up to 90% for gas–water on a five-spot pattern. A gas zone must be maintained between the miscible slug and the leading edge of the water, while sufficient gas must be injected with the water to form the gas vol being left in the water zone. If too much gas is injected the process will approach that of gas-driven miscible displacement; too little will give an approximation to water drive. In either case oil recovery will be good. G. D. H.

847. Gas well stimulation increases production and profits. P. Clinkenbeard, J. F. Bozeman, and R. D. Davidson. *J. Petrol. Tech.*, Nov 1958, **10** (11), 21–4.—Gas wells have been successfully stimulated by acidizing and fracturing. These techniques have been applied to new and old wells.

High-injection-rate acidizing treatment uses 15–75 brl/min. Sometimes an additive is employed to reduce action on rock already contacted by acid. Acid–oil emulsions have been effective, and have also been used for combined acidizing and fracturing. For fracturing thickened oil was used, but later thickened acid and water were employed.

Temporary plugging materials have been employed in both acidizing and fracturing.

The application and results of stimulation are described for areas in the San Juan basin, Oklahoma–Texas Panhandle and SW Texas, S Texas and Gulf Coast, and Arkansas–Louisiana–Texas.

When properly planned, note being taken of recent local experience, stimulation treatment is usually beneficial.

G. D. H.

848. Controlling sand in gas wells. G. Harper. *Petrol. Engr*, Dec 1958, **30** (13), B78.—Union Oil Co of California has achieved better than 85% success in the use of sand consolidating plastic in Gulf Coast gas producers and has found sand consolidation plastic an economic solution to the sand problem in gas wells. There is no indication that reservoirs are damaged through the use of these plastics, and wells have been depleted without restoring to expensive remedial measures.

Required flow rates can be safely maintained through high pressure equipment while handling as much as 1000 bd of salt water. The well is squeezed as soon as trouble is encountered. Average plastic-consolidation squeeze costs $1800/well, which is paid out in savings in water dump valve trim, lower maintenance cost, and added safety. M. F. M.

849. Preliminary report on fracturing by vibration—a new method of well stimulation. H. A. Metzger. *J. Petrol. Tech.*, Nov 1958, **10** (11), 13–16.—Vibration fracturing employs an explosive charge on a wire line. This charge is a specially designed retarded explosive and when set off under an adequate liq column generates rapidly oscillating pressure waves which send fluid into the formation. Pressures much higher than normal pump pressures are created, but they are of short duration. The latter feature minimizes the risk of damage to casing or cement bond. The aim is to weaken the formation or to create horizontal fractures. In cased holes the charge is centred on the perforations over the interval of interest; in uncased holes it is centred on the selected zone.

After vibration fracturing normal sand fracturing or acidizing can be applied at lower pressures.

The results of field applications are summarized. It has been used in water floods, both for injection and production wells. Permeability blocks have been overcome. Sandstones, limestones, and dolomites have been treated.

G. D. H.

850. Effect of rates on performance of Browning Unit water flood. F. F. Wright. *J. Petrol. Tech.*, Oct 1958, **10** (10), 12–14.—The Bartlesville sand at a depth of 2300 ft is lens-shaped. In 1928 a gas-repressuring programme began. This gave *ca* 3×10^6 brl of oil. Water flooding began in 1936 and the Browning Unit was formed in 1949, the early injection rates being low. Arbuckle and produced water are used in separate systems, the former being in a closed system. Since Feb 1955 the injection rate of 6000–8000 bd has been *ca* treble the early rates at which there was little increase in oil production. The higher pressures used later probably caused water to enter tight stringers not flooded before; there was a change in the slope of the water/oil ratio curve (semi-log basis) at the higher injection rates. G. D. H.

851. Successful Strawn sand water flood. E. A. Riley. *J. Petrol. Tech.*, Oct 1958, **10** (10), 20–4.—The Cherrykirk (Strawn) field produces from a sand lens at a depth of 2290 ft. Primary production gave 750,000 brl in 2½ years. Solution gas drive was estimated to be able to give 20% of the 3,141,000 brl of oil originally estimated to be in place.

The pilot flood had six injection wells and two central producers. The sand was 11 ft thick. Initial flood response occurred after *ca* 4 months, when a well rose overnight from 13 to 29 bd and 2 months later reached 160 bd of oil.

Extension of the flood to the whole field involved 25 injection wells and 24 producers. Injection began in Aug 1956. A peak oil rate was attained in March 1957. It is believed that flood recovery will approach primary recovery.

Development costs for the flood were $487/acre. Some of the wells were fractured. G. D. H.

852. The effect of curtailment on water flood recovery. P. D. Torrey. *Petrol. Engr*, Dec 1958, **30** (13), B71.—Many operators are convinced that curtailment of oil production has an adverse effect on ultimate recovery in water injection projects. Others think this is not so. In this paper the author presents an interpretation of the arguments on both sides. The conclusions are that economic conditions have influenced many of the opinions expressed on this subject. The profit motive is as important in the development of secondary oil reserves as in the development of primary oil reserves. If the economic factor of time did not reduce income, there would probably be little complaint about the damage resulting from pro-rated secondary oil production. M. F. M.

853. Increased effectiveness of hydraulic fracturing of formations. (In Polish.) Ya. V. Voszik, K. A. Oganov, and V. Ye. Yaniv. *Nafta (Krakow)*, 1958, **14**, 79–80.—Schodnica field produces from a formation that was tapped for the first time 60 years ago, and secondary production methods were applied some 30 years ago. These were the pumping of air and gas, but they have proved too expensive. Since *ca* 40% of the crude still remains in the sands fracturing has been applied since 1956. As the operations were extended yields grew. Emulsified crude and water were used as the carrier. A map of the field and a table of wells are included. M. S.

854. Effect of fractures on sweep-out pattern. A. B. Dyes, C. E. Kemp, and B. H. Caudle. *J. Petrol. Tech.*, Oct 1958, **10** (10), AIMME Tech Paper No. 8033, 245–9.—Fluid-flow model studies involving vertical fractures of various lengths and using different mobility ratios have been made to find the effects of fracture treatments on sweep-out efficiency in injection operations. One case of a horizontal fracture was examined. It was concluded that fractures up to one-half the spacing in length do not cause serious harm to the sweep-out pattern. Longer fractures do not harm the sweep if directed between the producers. If a long fracture is directed towards a producer a larger throughput is needed for a given recovery, but ultimate recovery drops markedly only when the length exceeds three-quarters of the spacing.

Fractures in injection and producing wells differ in effects. With the higher mobility in the swept region flood behaviour is better with the fracture in the producing than in the injection well for fractures directed towards the offset well.

Often differentiation between short and long fractures is possible by the analysis of productivity and pressure build-up data. Studies of results for many wells up to 1955 indicated on average a less than twofold increase in productivity by fracturing. G. D. H.

855. Linear water flood behaviour and end effects in water-wet porous media. J. R. Kyte and L. A. Rapoport. *J. Petrol. Tech.*, Oct 1958, **10** (10), 47–50.—Water flood studies have been made on water-wet alundum cores using high and low oil/water visc ratios. Water arrival at the outlet end, as distinct from water break-through, was detected by indicator on the outlet end in conjunction with a little ammonia in the flood water.

At low values of the scaling coeff the outlet end effect can appreciably distort flooding behaviour; it delays water production, thereby giving excessive oil recovery at water breakthrough. There is little distortion when the scaling coeff is high enough to give stabilized flooding conditions. At high rates and high oil/water visc ratios the inlet end effect leads to early water breakthrough in water-wet cores.

Stabilized water floods in water-wet cores are not appreciably distorted by end effects. Since most field water floods are stabilized, this means that lab tests should be stabilized, and this is usually possible by having a total pressure drop of 50 psi or more regardless of the core length. G. D. H.

856. Control of borehole cementation by radioisotopes. (In Polish.) S. Plewa and T. Rokosz. *Nafta* (*Krakow*), 1958, **14**, 34–7.—Radioactivity of rocks can be artificially increased by activating them with radioactive fluids. By determining gamma activity before and after such operations, more permeable horizons can be picked out, and this method is being used by the Polish Institute of Petroleum and the Mining and Smelting Academy. The choice and form of isotope to be used is thoroughly discussed. In the U.S.S.R. radioactive solutions and sands are employed. Zirconium-95, zinc-65, and cæsium-134 are employed in search for technical faults because of their convenient half-life times. Less use is being made of cobalt and iodine, while ^{59}Fe is hopeful for activation of sand. ^{131}I and ^{3}H are employed in water flooding control. In the U.S.A., iodine-131 and iridium-192 are commonly used; powders are the usual form of application. Advantages of tritium are well realized. In Poland Zn and Fe are being used. In particular, work is described in which an answer was sought to a problem of origin of some waters and authors describe their work in fair detail. Zn isotope was placed instead of a "bullet" in a barrel of a perforator, which was lowered below the horizon tested. After an explosion which shattered the ampoule containing radio-Zn and stirring the device in well, water from the bottom of the well was pressed into the formation. Once the well was washed, readings were taken and these showed a crack in casing. M. S.

857. Electric heater below the pump for warming boreholes with brine. J. Nawrocki and W. Machnik. *Bull. Polish Inst. Petrol.*, 1958, **8**, 1 (suppl. to *Nafta* (*Krakow*), 1958, **14**).—Successful trials have been conducted using the heater described, which is also illustrated. Leads are made of copper and insulated with water-, oil-, and gas-resistant material "Igelit." This is not, however, heat-resistant, and can be employed only where the temp never exceeds 60° C. M. S.

858. Economic factors in bank loans on oil and gas production. C. R. Dodson and J. S. McGee. *J. Petrol. Tech.*, Oct 1958, **10** (10), 27–30.—The average price of U.S. crude has shown two major cycles since 1900, and a comparison of the crude oil price index with the wholesale price index for all commodities since 1918 shows that there is similarity in behaviour, although the oil price shows rather greater fluctuations. Variations in oil production, after removing the growth factor, have been compared with similar data for oil demand and the Gross National Product. Again there is similarity in the cyclical fluctuations, with minor variations superimposed on the major changes. Before 1935 oil production was more variable than GNP; since 1935 it has been more stable than GNP. It seems that in the future crude oil production will conform very well with general economic activity.

In fixing loans a banker must beware if he believes that oil prices and production will continue to fluctuate with general business conditions. Prudence demands that he should not make a term loan that relies on future price increases. Prices can decline. If there is a drop production is curtailed by proration, taxes and costs rise, and the repayment time for a loan may have to be extended; there may even be a loss. A banker may be justified in the case of some loans in requiring more than the usual two-to-one safety factor. It is also noteworthy that the accuracy of reserve estimates is never expected to be better than $\pm$10–15%. G. D. H.

859. Saudi Arabia's rising resources. Anon. *Petrol. Press Serv.*, 1958, **25**, 341–4.—Despite the many political and physical difficulties encountered in the Middle East, more concerns are attracted there and more capital is invested by producing companies. ARAMCO continues to search for oil and is spending $63 million to increase productive capacity. The world's oil production capacity is increasing still more rapidly than demand and—in view of new reserves discovered in the Middle East and N Africa—the prospect is for further increases. In the problem of selling the oil ARAMCO has the advantage of connexion with American parent companies, an advantage tempered by U.S. import restrictions and foreign exchange problems. Partly owing to the Suez Canal closure and reduced demand in major oil-consuming countries there has been no marked increase in Saudi Arabian production. Saudi Arabia has produced recently its 3000 millionth brl of crude oil, and proved reserves at 1957 end—following discoveries made on land and offshore—were estimated at 35,000 million brl. At Ras Tanura refinery a 15,000-bd $5·5 million cat desulphurizer went into operation in 1957. In 1958 facilities for aviation gasoline production were under construction, including an alkylation plant. Facilities for producing liq gas will be increased. Productive capacity is being increased by gas and water injection projects at Abquaiq and 'Ain Dar fields. Extensions to the shipping terminal and Tapline's capacity will increase handling capacity. ARAMCO has done much to improve conditions for its employees. Oil revenues—the only substantial source of government revenue—would have been ~$335 million in 1957. R. T.

860. To Argentina's rescue. Anon. *Petrol. Press Serv.*, 1958, **25**, 324–6.—Rapid development of Argentina's oil consumption—now *ca* 13 million metric tons pa—has added difficulties to YPF, the autonomous state body's task. Particularly since world war II Argentina has suffered from political

phobia of private capital engaging in search and development of its oil resources. Despite popular antagonism—with a view to developing Argentina's oil resources—President Frondizi, self-constituted President of YPF—by-passing administrative problems, announced overseas help involving work and supplies ~ $1000 million and reorganization of YPF, still the responsible state body. A contract with the Consortium comprising several U.S. and one German firm is for work valued at $700 million extending over six years. This embraces drilling of 4000 wells in the Comodoro Rivadavia, possible building of a 26–30-inch gas line from there to Buenos Aires with a branch to Plaza Huincul, and a supply of crude valued at $50–100 million. An oilfield equipment plant is to be established. The Consortium's production, beginning in 1958, is to rise to *ca* 50 million bd in 1964. Credits for oil and equipment imports will bring relief to foreign exchange resources. Pan American International will drill 50 wells in the proved Comodoro Rivadavia and, dependent on the first year's results, a further five rigs will be working. Production of 30,000 bd within two years is foreseen. Under contract Pan American acquires the right to supply YPF, at competitive prices, with imported oil equiv to ⅓ of YPF's 1957 crude imports of 15–20 million brl. This constitutes an outlet for oil found in the Persian Gulf (see *Petrol. Press Serv.*, 1958, **25**, 221). A deal for crude oil from the U.S.S.R. is reported. A new Petroleum Bill is before Congress to bring subsoil rights under Republic ownership. Substantial oil reserves are believed to exist. R. T.

861. Conference of the Permanent Council of Petroleum Industry on production. (In Polish.) Z. Bajger and W. Schiller. *Nafta* (*Krakow*), 1958, **14**, 53–4.—Conference took place in Bucharest in Dec 1957 with participation of all E European states. Among particularly successful methods were mentioned: internal flooding (U.S.S.R.), adding water to the formation water (Rumania), thermal treatment of the formation (Poland), pumping in mixed water and gas (Hungary), and pumping in bacteria in order to raise production (Czechoslovakia). Other methods were reviewed and suggestions for their more efficient application noted. M. S.

OILFIELD DEVELOPMENT

862. World crude output due to increase sharply. Anon. *World Oil*, 15.2.59, **148** (3), 107.—A peak world oil production of *ca* 19,650,000 bd is expected in 1959, 8·5% higher than output in 1958. The increase will be due to continued expansion of production outside the U.S.A. and a substantial increase in U.S. production. Tables show world and U.S.A. crude oil production, by years since 1918, and world crude oil production, by countries, 1957 and 1958, and cumulative through 1958. C. A. F.

863. 10·7% of U.S. wildcats produce in 1958. Anon. *World Oil*, 15.2.59, **148** (3), 128.—*Ca* 10·7% (or 1043) of the 9762 wildcats drilled in the U.S.A. in 1958 found oil, gas, or dist production, compared to 10·4% in the previous year. Average over the past 21 years is 11·9%. In the Texas Panhandle 25·2% of the wildcats in 1958 were successful, and in N Mexico there were 20% successful. C. A. F.

864. Oil reserves show first drop in 14 years. Anon. *World Oil*, 15.2.59, **148** (3), 158.—At the beginning of 1958 U.S.A. proved oil reserves were 349·2 million brl, 0·97% less than the previous year. This was the first annual decrease since the 18·6 million brl deficit of 1943. At the current production rates the U.S.A. has a supply of proved recoverable liq hydrocarbons for 12·4 years, the lowest ratio since 1948. Total oil discovered in 1957 was 2·6 billion brl, the lowest figure since 1945. C. A. F.

865. New field discoveries at eight year low. Anon. *World Oil*, 15.2.59, **148** (3), 130.—1043 new oil, gas, and dist fields were found in the U.S.A. in 1958, 138 less than in 1957, and 401 less than in the record year of 1955. The best area in 1958 was Texas, where there were 132 new finds in the N and 127 in the W. Kansas was second in new field discoveries (151), and Oklahoma was third (119). C. A. F.

866. Four per cent gain forecast for U.S. drilling in 1959. Anon. *World Oil*, 15.2.59, **148** (3), 91.—An estimated 50,275 new wells will be drilled in the U.S.A. in 1959, 4% more than in 1958, but activity is not expected to be as high as in 1957 and 1956. 1956 was a peak year when 58,418 wells were drilled. The improved outlook is due to a probable increase in demand following the general business recovery. During 1958 there were drastic cuts in production and refinery output and limitations of crude imports. Several factors will tend to restrict drilling gains; these include cost increases (without price gains) and the failure of the U.S. Government to establish a firm import policy. Tables show forecast of wells and footage to be drilled in 1959, and wells completed annually in the U.S.A. C. A. F.

867. Average depth per well 4052 ft in 1958. Anon. *World Oil*, 5.2.59, **148** (3), 113.—Average well depth in the U.S.A. in 1958 was 4052 ft, slightly deeper than for the previous year. 48,331 wells were drilled in the U.S.A. during 1958, compared to 53,783 in 1957. A table shows annual average depth of new wells in the U.S.A. since 1945. C. A. F.

868. Two world depth records set in the U.S. during 1958. Anon. *World Oil*, 15.2.59, **148** (3), 114.—Eight wells below 20,000 ft have been drilled in the U.S.A., and in 1958 the world's deepest well was University EE-1 in Pecos County, W Texas, at 25,340 ft. This took over two years to drill and was perforated from 22,310 to 22,500 ft. The second deepest well is Rumberger 5 in the Elk City field, Oklahoma, at 24,002 ft. Several other states showed drilling depth records in 1958, and *ca* 70% of the 46 oil and gas areas in the U.S.A. now have wells below 10,000 ft. Tables showing annual depth records and regional drilling depth records for the U.S.A. are included. C. A. F.

869. U.S. crude production increase is anticipated during 1959. Anon. *World Oil*, 15.2.59, **148** (3), 99.—Domestic crude oil demand in the U.S.A. in 1959 is estimated at 7,280,000 bd, 8·5% higher than the daily production in 1958. Peak year was 1957, when 7,170,000 bd were produced. Consumption has recently increased markedly, and demand for all oils is expected to increase by 4% during 1959. The import situation is uncertain and is complicated by the artificially low rate of U.S. production in 1958, due to abnormally heavy crude and refined products withdrawals from storage.

Of the 30 producing states, 18 showed a decreased production in 1958. Texas, the largest producer, declined by 12%. Tables show U.S. crude oil production, by states and districts, 1957–58, and annual and cumulative production. C. A. F.

870. North Dakota bags ten in first month. F. J. Gardner. *Oil Gas J.*, 9.2.59, **57** (7), 147.—Ten new fields and important extensions were found in N Dakota in Jan 1959, and the area is expected to have a record discovery year following successful exploration in 1958, when 25 new fields were found. The finds are in the N part of the state in the Williston basin close to the Saskatchewan border. Production comes mainly from the Mississippian, but deeper pays are being sought in the Silurian on the Nesson anticline. The Trias Spearfish has also been found productive, and a well on the W flank of the anticline found Devonian production at approx 10,000 ft. C. A. F.

871. Alert explorers find Kansas oil. D. F. Merriam and E. D. Goebel. *Oil Gas J.*, 2.3.59, **57** (10), 166.—The history

of oil development in Kansas is outlined. The state produces *ca* 5% of requirements in the U.S.A., and exploration and development have been maintained at a high level. During the last 40 years the number of new oil and gas fields found each year has generally increased, in spite of rising costs, and the percentage of dry holes has risen as the best prospects have decreased. The chances of finding a major field are decreasing, but up to 1957 at least 180 fields had produced over 1 million brl. Production is continually increasing, the average for 1957 being 354,461 bd. The estimated reserve for Kansas is at present *ca* one-third of the cumulative production, and this is being maintained by increased drilling; the success ratio is higher than the national average. New techniques developed in recent years enable marginal production to be developed more efficiently. Tables show statistics of Kansas oil development. C. A. F.

TRANSPORT AND STORAGE

872. Ocean transport of natural gas and liquefied petroleum. (In Italian.) L. von Szeszich. *Riv. Combust.*, 1959, **13**, 105–21.—Several institutions and industries in Europe and the U.S.A. are considering the possibility and advantages of overseas transportation of fuel gases under ordinary pressure, but at a lower than bp temp. Beyond a certain quantity limit (as an average, 500 tons/day) this method is more convenient than conventional transport under pressure. The author analyses the various technical and economic problems involved in liquefied fuel gas transportation and illustrates the present state of research and projects of suitable tankers for the said transport. After a brief survey of re-gasification and the possibility of employing refrigeration, a discussion follows on investments connected with liquefying, stocking, overseas transport, and re-gasification operations.

(Author's abstract.)

873. A 34,000-ton twin-screw tanker. Anon. *Mot. Ship*, 1958, **38**, 558.—The *Stora* is equipped with two 7500-bhp at 112 rev/min Götaverken engines. The cyl dia is 760 mm, and the piston stroke, 1500 mm. Tables show particulars of the cargo tanks and those for water and fuel oil. D. K.

874. Doxford turbocharged-engined tanker. Anon. *Mot. Ship*, 1958, **38**, 570.—Trials of the 19,000-ton tanker *Spinanger* are reported. Details of the ship trials of the main engine are included. D. K.

875. Corrosion control in tankers. A. Logan. *Mot. Ship*, 1958, **38**, 554.—The cost, pattern, and nature of corrosion are discussed. The author describes his experiences with cathodic, paint, and inhibitor protection. D. K.

876. A 490-ton liquefied-gas tanker. Anon. *Mot. Ship*, 1958, **38**, 569.—The *Signe Tholstrup* is a shelterdecker with five spherical containers holding 275 tons of gas. A brief description of the vessel is given. D. K.

877. Counterbalanced loading booms for large tankers. Anon. *Petrol. Times*, 27.3.59, **63**, 198.—Details are given of the Kuwait North Pier Installation, which will be capable of berthing 2 × 100,000-ton and 2 × 50,000-ton tankers, with a maximum capacity of 300,000 dw tons.

Specially designed pier equipment will provide a quick turn-round, and each berth has four counterbalanced 52-ft booms to handle 12-inch and 8-inch flexible hoses. Operation of hose line is by two air-powered winches incorporated near tail of each boom, and control is from a cabin of Fibreglass with windows on three sides to give max visibility. G. A. C.

878. World tanker statistics fourth quarter 1958. Anon. *Inst. Petrol. Rev.*, 1959, **13**, 70–1.—Oil tankers under construction world-wide amounted to 339 ships of 5,497,170 gross tons during the fourth quarter of 1958. This was 613,609 tons above the figure for the corresponding quarter of 1957, and represented 55% of the total of world merchant shipping. Details of the registration of oil tankers under construction during this quarter are tabulated, and Britain is again the leading country of tanker registrations, with Liberia second and Norway third. A. D. S.

879. Solving gas-pulsation problems. R. E. Mayne. *Oil Gas J.*, 9.3.59, **57** (11), 113.—The Southwest Research Institute and the Southern Gas Association have combined to use an electro-acoustical analogue which simulates compressor-plant operations electronically to solve gas-pulsation problems.

Pipe vibration is most usually associated with gas pulsation caused by reciprocating type compressors which deliver gas to the system in form of pulses, other causes being compressor clearance, speed, and gas temp.

The analogue can predict the performance of a filter used to remove disturbing frequencies, and simulates electronically the actions of a compressor and its suction and discharge lines. Compressor performance is observed from a pressure–vol diagram on an oscilloscope. Pressure–vol, frequency analysis, and frequency-transmission diagrams are shown. G. A. C.

880. Consider these factors in fabricating branch connexions. R. S. Ryan. *Oil Gas J.*, 9.3.59, **57** (11), 117.—Fundamental principles of welding, shrinkage stresses, residual stress, and stress concn are discussed, and the principles used as a basis for the specific application of branch connexions in the development of a sequence for welding various types of branch connexions.

Weld metal and heat-affected zone are very important in developing a weld joint; rapidity of the heating and cooling cycle severely affects the behaviour of the heat-affected zone.

Distortion caused by heating and cooling cycle is dependent on geometry of joint. Weld defects will produce stress concn, and the majority of failures occur at the toe of the fillet weld due to stress concn.

Figures show defects, stresses, distortion, and a sequence for branch connexions depicted by numericals. G. A. C.

881. United Gas has gas-turbine, ebullient-jacket water cooling. H. W. Egger. *Oil Gas J.*, 30.3.59, **57** (14), 184.—A gas-turbine centrifugal compressor unit installed at Napoleonville is the first to be used, and is on a 30-inch gas transmission line from S Louisiana to N Mississippi. The installation was successful in spite of widely varying flow rates, because of consistently high suction pressure available. The usual practice of jacket water cooling has been replaced by the use of ebullient-jacket water cooling, the heat in the steam thus generated being utilized to supply necessary power to drive the fan for steam compression and oil cooling. A vapour phase flow diagram is given. G. A. C.

882. Russian pipeline. (In Polish.) Anon. *Nafta (Krakow)*, 1958, **14**, 25–8.—In the review included is news of the gas pipeline Dashava–Minsk–Leningrad, with branches to Vilna and Riga, which will have a total length of over 1800 km. At Dashava in W Ukraine gas is found at 1000 m. It consists of 98% of CH_4 and has a cal val = 8500 kcal/m³ at NTP. The pipeline will be of dia 400, 500, and 700 mm and will be made of high quality thin-walled steel. Apart from Pripet marshes, the pipeline will cross 350 rivers and streams; pumping stations of total power of 80,000 hp will be installed; comunications will be maintained by radio. It will be ready in 1960. M. S.

883. Welded repairs on API 5LX52 steel pipe. R. D. Morel. *Pipe Line News*, March 1959, **31** (3), 25–31.—This report consists of a brief description of some of the considerations that are necessary in evaluating the repair problem of high-test line pipe. Several different types of welded repairs were made on a length of test pipe and were subjected to a hydrostatic burst test with strain-gauge readings being taken at each repair area.

The tests demonstrated that the welded repairs as made were satisfactory and withstood all the tests required by the specifications. The strain gauge data and other data collected during tests indicate interesting possibilities for further investigations. M. F. M.

884. Pipeline corrosion—a practical case of its control. R. F. U. Icely. *Pipe Line News*, March 1959, **31** (3), 41.—The Montreal plant of Carbide Chemicals Co recently experienced a complete shut-down of all the major processing units due to the corrosion of an underground raw material (gas) supply line. After the ruptured gas line was uncovered it was found that: (1) the pipe wrapping applied at the original installation had completely disappeared for a distance of *ca* 50 ft; (2) there was a break along the welded longitudinal seam *ca* 1 ft in length; the metal thickness near the break had decreased from 0·32 to 0·17 inches; (3) there was a general corrosive attack of the pipe surface where the wrapping had disappeared; (4) there was particular undercutting of the longitudinal welded seam.

The paper discusses the steps that have been taken in order to prevent a recurrence of the event. These steps include hydrostatic tests of the whole line, regular physical inspections, and a pipe-to-soil potential survey. M. F. M.

885. Internal coating of the pipelines—what does the future hold? W. D. Palmer. *Pipe Line News*, March 1959, **31** (3), 38.—There are at least five factors which either individually or collectively will influence the justification and future acceptance of internal plastic type coating of the pipelines. These are: (1) corrosion mitigation; (2) improved throughput; (3) contamination purity control; (4) paraffin control; and (5) reduction of abrasive wear and erosion by sand, etc.

The authors believe that all 8-inch dia and larger water lines laid in the near future will be coated inside and outside. Coating materials may vary from the vinyl family of resins to cold setting epoxy type coatings. M. F. M.

886. The submarine oil pipeline and sea terminal. R. M. Stall. *Pipe Line News*, March 1959, **31** (3), 31–7.—A submarine line sea terminal may be briefly described as a marine offshore facility for oil transfer located on a suitable anchorage ground and consisting of several anchored buoys and pipelines from shore storage tanks brought out on sea bottom to the area of mooring buoys. Terminals of this type have become a necessary, or economically desirable, link in the chain of oil transportation between the producing area and the refinery, or between refinery and marketing area.

Several important factors must be considered in determining the location of the site of a sea terminal, such as the degree of natural shelter, the water depths, the prevailing wind, sea and current conditions, the sea bottom conditions, and the topography and contours of the shore line.

This paper describes the general layout of sea terminals, the positioning of mooring buoys and pipelines, and it ends with a discussion of the advantages and disadvantages of this type of facility in comparison with other types. M. F. M.

887. Economic analysis of profitability of long-distance pipelines for petroleum products. (In Polish.) S. Bortkiewicz. *Nafta (Krakow)*, 1958, **14**, 75–7.—The analysis has been carried out with special attention being paid to the contours of Polish Lowlands. Distances investigated and throughputs were from 100 to 500 km and 15 to 240 m^3/hr along pipeline of dia ranging from 60 to 187 mm. American and Soviet assumptions about the costs and utilization respectively have been employed, but both were adapted to Polish conditions where necessary. Costs were eventually compared with Polish railway costs, and it has been shown that costs of pipeline transport fall with throughput and costs of rail transport fall with distance. M. S.

888. The Trans-Canada system—the story of the world's longest gas pipeline. Anon. *Pipe Line News*, Feb 1959, **31** (2), 22–51.—Trans-Canada's 2,294-mile natural gas pipeline from Alberta to Montreal provides market outlets for reserves of Alberta gas which have reached 22·5 trillion cu ft, according to latest estimates. This 30-inch pipeline, which is the longest natural gas line in the world, runs through the heart of a territory in which the bulk of Canada's 17 million people is concentrated.

The article describes in detail the story of the construction of this pipeline, the finance problems involved, procedures for acquiring the land, building of bridges, compressor and pumping stations, and important personalities of the Trans-Canada Pipe Lines Ltd. M. F. M.

889. Direct analytical calculation of pressure pipelines by means of the equation of Colebrook-White. (In Dutch.) L. Hendriks. *Ingenieur, 's Grav.*, 19.12.58, **70** (51), B283–4.—A formula is derived combining the equations of Colebrook-White with those of Darcy and de Chezy and allowing the direct calculation of pressure pipelines, etc. 3 refs. G. F. T. C.

890. Aerial survey and mapping aids in locating pipeline rights of way. (In Dutch.) G. Schipmolder. *Ingenieur, 's Grav.*, 24.10.58, **70** (43), B243.—After a review of the major facts governing the design engineering and construction of cross-country pipelines, a description is given of the route maps prepared from aerial photographs. The route maps may become an integral part of the final construction drawings. 16 figs. (Author's abstract.)

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

891. Refinery construction manual. Pt 6. Mechanical engineering and design. H. M. Noel. *Petrol. Engr*, Dec 1958, **30** (13), C19.—In this paper the author discusses how tanks, piping, and similar equipment are designed and selected. Tables provided show line capacities, pressure drops at various flow rates and pipe sizes, typical furnace dimensions and duties, and column sizes for various feedstocks (*i.e.* crude, gas oil, light gasoline, etc.). M. F. M.

892. Towers with bubble-cap trays. (In Serbo-Croat.) M. Sekardi. *Nafta (Yugoslavia)*, 1959, **10**, 1–10.—The article gives the theoretical explanation of the function of bubble-cap trays, of the process requirements placed on the good performance of bubble-cap trays, and the factors influencing the efficiency of the trays. Modern methods are given for the evolution of: (1) slot opening and number of caps per tray; (2) liq ht over weir; (3) liq throw over weir; (4) liq gradient per tray; (5) dynamic slot submergence; (6) pressure drop per tray; (7) vapour distribution per tray; (8) liq ht in downcomer; (9) liq residence time in downcomer; (10) entrainment; (11) tray efficiency.

Some new diagrams for evolution of the liq ht over weir are given. (Author's abstract.)

893. Oil-immersed or oil-less electric switching equipment for refining application? L. T. Ellis and W. R. Morton. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 147–56.—The selection of oil-immersed or oil-less electric switching equipment should be based upon an overall evaluation of the problems of hazardous atmospheres, corrosion, reliability, maintenance, installation, and cost. This paper relates application of electric switching equipment with respect to these criteria. The discussion is intended to stimulate the refinery engineer to more accurately and completely evaluate specific application situations. A general formula for application is not evolved. The discussion indicates the challenge of a design and application situation to the refining industry and electrical manufacturers. Co-operative effort towards unification of engineering thinking on these matters could well result in fewer designs and lower overall cost. (Authors' abstract.)

894. Possible approaches to the design of control equipment for Class 1, Division 2 locations. H. A. Wright. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 160–6.—Now that API Standard RP-500: Recommended Practice for Classification of Areas for Electrical Installations in Petroleum Refineries is being more generally followed, there has been a considerable increase in the classification of locations as Class 1, Division 2 areas. A complete line of electrical equipment is not available for Division 2 areas, nor have the necessary design standards been established. Both the equipment and standards must be developed together. To this end, there are a number of possible approaches, *i.e.* the Davy miners' lamp principle, intrinsic safety, inherent safety, contactless switches and devices, hermetic sealing, oil-immersed equipment, and purged rooms. (Author's abstract.)

895. The manufacture and application of mineral-insulated, metallic-sheathed cable. W. J. Richard. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 138–46.—Mineral-insulated, metallic-sheathed (Type MI) cables, although relatively new in the U.S.A., have been used extensively abroad for many years. This cable contains no organic materials and only two basic inorganic materials, copper and magnesium oxide, are employed in its design. The copper is used for the conductors and the outer sheath, and the magnesium oxide is used for the insulation. Mineral-insulated cable is completely non-flammable and will not give off any toxic, combustible, or explosive gases. The only temp limit on the cable in short-time exposure is the mp of copper itself. The cable is manufactured from a " starting assembly " as a complete unit by a succession of drawing operations through dies with intermediate and final annealing operations. The method of manufacture, design features, physical and electrical properties, installation techniques, and the principal uses are discussed in the paper. (Author's abstract.)

896. New developments in calculation of pressure vessels. (In Dutch.) W. P. Kerkhof. *Ingenieur, 's Grav.*, 15.8.58, **70** (33), Ch 47.—New developments take into account high strain fatigue, local corrosion fatigue, or stress corrosion. Membrane stress has not much meaning unless stress concentration is known. Stress range should be used in calculation instead of max absolute stress. Allowable value of stress range is dependent on stress distribution. Stress distribution can be improved by better design and manufacturing method. 10 figs. G. F. T. C.

DISTILLATION

897. Computer gives best splitter design. M. A. Albright. *Petrol. Refin.*, Dec 1958, **37** (12), 111–14.—Fractionating towers need to be designed for optimum operation, and one of the major decisions to be made by design engineers is the choice of proper ranges to give the optimum operating conditions. This choice will affect all of the physical design and operation economics and therefore the profits from the column. In the past, optimum economic conditions have been developed through trial and error procedures. Nowadays high-speed digital computers can aid the design engineer in the phase of fractionator design.

A sample case is presented in the paper showing how to find optimum economic set of operating and design parameters for a pentane splitter processing 10,000 bd of feed (50% n C_5, 50% i C_5) with overhead purity of 95% and bottoms product purity of 85%. The answers derived are as follows: pressure, 60–70 psi with air condensing or 40–50 psi with water condensing. Reflux ratio 120–130% of minimum reflux. Feed condition, saturated liq at its bubble point. M. F. M.

CRACKING

898. WPRA refining quiz. 3. Coking. W. L. Banks, G. Jandacek, *et al. Oil Gas J.*, 9.3.59, **57** (11), 178.—The third part of the series includes questions on experience with delayed coking units in relation to use of anti-foam agents, optimum geometric arrangement of coke-drum-level detectors, reduction of coke-drum pressure for increased gas-oil yields in delayed coking, and coke-cutting procedures to minimize coke-fines production.

4. Alkylation. W. L. Banks, G. Jandacek, *et al. Oil Gas J.*, 16.3.59, **57** (12), 167.—Pt 4 includes questions on types of distribution of fluorides produced in HF alkylation, impellor-driven contactors, use of mol sieves for driers, comparisons of F-1 and F-4 octanes of HF and H_2SO_4 alkylate, experience with cascade reactors, methods of neutralizing HF units for turnarounds, removal of diolefins, and effect of mercaptans in the feed on acid consumption. G. A. C.

SPECIAL PROCESSES

899. Cryogenics—key process and research tool. J. E. Nachod, Jr. *Petrol. Engr*, Dec 1958, **30** (13), C12.—Cryogenics is the science of extremely low temp and cryogenic technology, as applied to the separation of gases, has become an important process in recent years. Low temp technology can be divided into four principal areas. (1) Gaseous separation—argon, carbon monoxide, ethylene, methane, hydrogen, oxygen, and other gases can be purified by this method at low cost. Impurity levels are normally reduced to a very few ppm. (2) Energy storage—high energy gases are liquefied and transported economically (*i.e.* ethylene, methane, ozone, etc.). (3) Sensitive measurements. Ir radiation from very distant sources, for instance, may be measured and interpreted for military detection purposes. (4) Basic research—development of fundamental information on the properties of materials in extreme temp environments brings the observer closer to the understanding of such materials.

The gaseous separation field is discussed in some detail. Low pressure cycle, medium pressure cycle, and high pressure cycle methods for the production of oxygen from air are analysed and flow sheets are given. Power cost comparisons are made in tabulated form. M. F. M.

900. How CO_2 removal plants are working. R. O. Palo and J. B. Armstrong. *Petrol. Refin.*, Dec 1958, **37** (12), 123.—Successful application of hot potassium carbonate process to natural gas is shown in the operating data from two units built in 1957 at Taft, California. In one of these plants (AP-2) the CO_2 content is reduced from 8% to less than 1% by countercurrent treatment with a 20% potassium carbonate soln. The contactor is a 30-inch id vessel with 23 stainless

steel perforated plate trays on 24-inch spacing. The gas pressure on entering the contactor is 400 psig. On the second (1-C plant) unit, CO_2 removal facilities are located on the intake side of the gasoline extraction facilities. Here again the gas pressure is 400 psig and the full gas stream (approx 38,000 Mcfd) is processed through the contactor.

Full operating data for the plants are given in the paper and various problems and difficulties encountered (*i.e.* cavitation problem, plugging, etc.) are discussed. Performance of these two plants has demonstrated the industrial application of the hot potassium carbonate process for the removal of CO_2 from natural gas. The advantages of this method, as compared to amine process, are: (1) lower construction cost; (2) considerably lower heating and cooling requirements; and (3) negligible loss of agent. Furthermore, the presence of approx 0·3% oxygen in the intake gas has not been troublesome, whereas oxygen in an amine plant results in severe corrosion problems. M. F. M.

PRODUCTS

CHEMISTRY AND PHYSICS

901. Effect of the carrier gas on the sensitivity of a thermal conductivity detector in gas chromatography. L. J. Schmauch and R. A. Dinerstein. *Nature, Lond.*, 1959, **183**, 673.—In the eqn for the sensitivity of a thermal conductivity cell derived by Ray (Abs. **533**, 1959), the constant is not α but α/K_1. Therefore the sensitivity is prop to $(1 - K_2/K_1)$ and is greatest for high values of K_1 and not low values as Ray suggests. N. H. Ray replied: the value α/K_1 is constant only if the temp of the hot wire is the same. In practice, however, it is usually not possible to achieve this because the bridge supply voltage is fixed at a value for use with gas of low conductivity. H. C. E.

902. Light emission form insulating liquids due to excitation by dc fields near breakdown. M. Darveniza. *Nature, Lond.*, 1959, **183**, 743.—Visible light is emitted from a degassed transformer oil ex Peruvian crude at dc fields >600 kV/cm. Fractional dist of the oil results in much less emission and increases the breakdown strength from 1100 to 1300 kV/cm. Similar results are obtained with hexane containing 1 g/l of anthracene or *p*-terphenyl.

It is concluded that those impurities in the oil adsorbing energy by resonance of electron orbitals into higher states, *e.g.* anthracene, may be excited by high dc fields in the liq state, and the processes involved play some part in the electrical breakdown of the medium. H. C. E.

903. Gas phase oxidation of hydrocarbons: endothermic nature of the initial stage of reaction. K. C. Salooja. *Nature, Lond.*, 1959, **183**, 602.—The pre-flame reactions of a number of hydrocarbons in a flow system in a silica reaction chamber have been studied. The chamber is contained in a furnace at controlled temp, and thermocouples measure the temp inside the chamber and on the outside surface.

The fuel and air are pre-heated and allowed to flow at desired rates into the chamber, the temp of which is gradually raised. O_2, CO, and CO_2 concn of the effluent gases are measured. At the first sign of consumption of O_2 the temp of the reaction mixture falls below that of the chamber surface; as the chamber temp is raised, oxides of carbon are formed in appreciable amounts, and the temp of the reaction mixture rises above that of the chamber surface. *E.g.* for a stoichiometric *n*-heptane/air mixture with a residence time of 0·9 sec in a chamber with surface/vol ratio of 3·3 cm^{-1}, a drop in temp of 4°–5° C is observed. Such a drop is held to indicate the existence of the endothermic reaction $RH + O_2 \rightarrow R. + HO_2$. H. C. E.

904. Cohesive energy density of polystyrene. J. H. S. Green. *Nature, Lond.*, 1959, **183**, 818–19.—Visc measurements on polystyrene soln in a range of solvents are used to calculate the polymer-solvent interaction constant according to the Flory-Fox equation. Substituting the value in the Huggins equation relating the cohesive energy densities of solvent and polymer leads to a figure of 75 ± 2 cal/cm^3 for the cohesive energy density of polystyrene. A. D. S.

905. Further developments in the chemistry of the atmosphere. W. E. Scott *et al. Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 171–83.—The technique of long-path ir spectroscopy is currently being used at the Franklin Institute both for direct studies of atmospheric pollution and for lab experiments. The first long-path instrument has been used in Philadelphia for more than two years for studies of chemical reactions under simulated atmospheric conditions. A second instrument, similar to the first in design, has been in use since Aug 1956 for the study of atmospheric pollution in the Los Angeles area.

With the field instrument, which is housed in a trailer, concn of most of the important pollutants in the Los Angeles atmosphere have been measured as a function of time and meteorological conditions. These studies have borne out the general picture of atmospheric pollutants and their reactions which was developed from lab studies both at the Franklin Institute and in other lab. From the lab studies it was concluded that the concn of nitric oxide and nitrogen dioxide would be quite low in smog. Inasmuch as a new organic nitrogen cpd, identified as peroxyacyl nitrite, was a prominent product in the lab studies, it was predicted that this cpd would be found in the smog. Both of these conclusions have been confirmed by direct atmospheric analysis. The presence of ozone, long used as the primary smog indicator, was also confirmed.

Typical air analyses for several major pollutants, made after sundown, show a close similarity to an analysis of diluted automobile exhaust and to an analysis of air taken near a heavy traffic centre.

Several cpds whose presence in polluted air has been suspected were found to be below the limit of detectability. Among these are formic acid, nitric acid, and methanol. Aldehydes do not appear to be a major contaminant.

Ir analyses of the products of reactions of ozone with various olefins at low concn (30–60 ppm) show that the products identified include aldehydes, carbon monoxide, carbon dioxide, water, and, from propylene and 2-pentene, ketene. Other products of the reaction between ozone and the higher olefins are indicated by the spectra, but have not yet been identified. Measurement of the yield of carbon monoxide and carbon dioxide by these reactions indicates a definite connexion between chain length and the decomposition of products. No evidence of ozonide formation was obtained with ethylene and propylene, and little, if any, was formed from 1-pentene, 2-pentene, and 3-heptene. Several pure ozonides were prepared at low temp, and their ir spectra recorded. In some cases the decomposition products were determined.

(Authors' abstract.)

ANALYSIS AND TESTING

906. Analysis of hydrocarbons. H. M. Frey. *Nature, Lond.*, 1959, **183**, 743–4.—Mixtures of ethane, ethylene, propane, and propylene can be analysed using gas–liq chromatography, by means of a single column, packed with acetonylacetone on firebrick operated at 0° C. Resolution of all possible isomers of the C_3 to C_5 hydrocarbons, including many cyclic isomers,

can be achieved. The difficult analysis of *iso*butylene and but-1-ene in presence of other hydrocarbons can also be carried out. 1,1-dimethy*cyclo*propane and 3-methyl but-1-ene cannot be resolved using this column, but can be on a column of a solution of silver nitrate in ethylene glycol on fireclay. A combination of the two columns can be used for analysing the latter two hydrocarbons in presence of other C_2 to C_5 hydrocarbons. A. D. S.

907. Gas chromatographic analysis of C_1–C_4 hydrocarbons by magnesium silicate. (In Italian.) V. Crespi and F. Cevolani. *Chim. e l' Industr.*, 1959, **41**, 215–17.—In a 1–2 m length column, packed with magnesium silicate, the separation of C_1–C_4 hydrocarbons has been carried out easily, with retention times sufficiently short. Material studied and proposed has given excellent results in a series of analyses of different hydrocarbon streams containing also butadiene. (Authors' abstract.)

908. Btu's in natural gas. R. D. Northcutt and G. M. Couch. *Oil Gas J.*, 9.3.59, **57** (11), 161.—A new graphical method is given which permits rapid approximation of Btu content of natural gas with only a limited amount of data. A sample determination is shown, and the Btu content calculated from the specific gravity, CO_2, nitrogen, and sulphur contents. G. A. C.

909. Automatic analysis apparatus in petroleum refining and natural gas processing. Anon. *Bull. Ass. franç. Tech. Pétrole*, 1958, 619–38.—Brief descriptions (diagrams) of equipment for measuring density (magnetic or photo-electric hydrometer, various types of density balances (including gas), γ-ray absorption), accuracy of all these are similar at 2–3%; dist curve (±0·6° C) and also app limited to ibp (±1° C) and, to fbp (±4° C); vap press (±40 g/cm²); flash (30°–82° C, ±1·5° C); visc (flow or rotational, ±1%); dielectric const (change of this in reformer product as compared to feed is indication of ON improvement, since dielectric const of aromatics is high); dew point of natural gas (±1° C); differential refractometer (±1%); S in gas (oxidn by Br, concn of latter maintained const electrolytically). V. B.

910. Applications of optical microscopy to the control and testing of lubricating greases. (In French.) B. Bernelin. *Chim. anal.*, 1959, **41**, 89–93, 137–45.—See Abs. **520**, 1959.

911. Correlation between physical properties of organic compounds. (In Spanish.) V. G. Aranda. *Combustibles* (*Zaragoza*), 1958, **18**, 153–62.—Inter-relationship derived between d and n, leading to expression of type $d = An + B$. Tabulation of expt and calc values (including values for A and B) is given for alkyl*cyclo*hexanes (C_6–C_{32}) and 1- and 2-alkanethiols (C_1–C_{20}). V. B.

912. Ring analysis diagrams for saturated mineral oil fractions. Supersonic velocity, surface tension, and Verdet constants for estimating ring content of saturated mineral oil fractions. (In German.) J. Cornelissen, J. A. Waterman, and H. I. Waterman. *BrennstChemie*, 1958, **39**, 84–6.—The ring No. of saturated mineral oil fractions can be determined from supersonic velocity u_{20} with frequency 2×10^6 Hz at 20° C (in m/sec), surface tension σ_{20} at 20° C (in dyn/cm), or the Verdet-const V_D^{20} at 20° C (in min cm^{-1} gauss^{-1}) by plotting as illustrated, as a function of n_D^{20}. Physical const of saturated mineral oil fractions used in this article are tabulated. The formerly unknown relation between the Verdet-const, kin visc, and n is presented in a further chart—and tabulation—on which log v_{20}–n_D^{20} lines for const V-val are drawn. Results of the ring analysis obtained with the help of these diagrams can be compared with those of the n–d–M analysis. 12 refs. R. T.

913. Estimation of the darkness of smoke by visual methods. L. E. Reed. *J. Inst. Fuel*, 1959, **32**, 3.—Tests have been made comparing results obtained by using an optical instrument, the Telesmoke, with those obtained from the Ringelmann chart and those noted by an observer with the naked eye and a photoelectric smokemeter. Similar results were obtained with the chart and the Telesmoke. But the Telesmoke is more convenient to use and imposes less strain on the observer if a number of readings have to be made. D. K.

914. A radioactive corrosion probe. P. Anson. *J. Inst. Fuel*, 1959, **32**, 10.—The design and performance of a simple prototype probe is described. It was demonstrated that accurate results should be possible using probe exposure times as short as 10 minutes and counting times of 2 minutes with conventional counting equipment. Health hazards due to radioactivity are slight. D. K.

CRUDE OIL

915. Technical analysis of Tuymazy crude. (In Polish.) S. Hypta. *Bull. Polish Inst. Petrol.*, 1958, **8**, 1–2 (suppl. to *Nafta* (*Krakow*), 1958, **14**).—The Analytical Establishment of the Polish Institute of Petroleum has carried out the analysis by dist of fractions up to and including jet fuels using Gadaskin's apparatus, and then vacuum distilling other fractions and analysing each chemically. Some results are given as follows: sp gr (20° C) = 0·861; water = 1·52%; S = 1·02%; coke = 3·28%; hard asphalts = 0·68%; wax (of fp +53° C) = 2·63%; pour pt. = −12° C; ibp of crude = 61·5%. Motor spirit has insufficient of highly volatile constituents. This fraction forms 26·4% of the total and is followed by 18·2% of kerosine. Alternatively, only 9·9% of light gasoline is distilled off to allow 18–22% of jet fuel to be obtained. Lub oil fractions are of poor quality. M. S.

GAS

916. Liquid methane—a cheaper means of peak shaving? A. R. Young. *Oil Gas J.*, 23.3.59, **57** (13), 75.—Design data investment and operating costs developed from large-scale plant designs are discussed. A 6–8 MMcf liquefaction unit supplying liq methane for the cargo filling of the *Methane Pioneer*, jointly owned by the British Gas Council and Constock International Methane Ltd, is the basis for economical designs for future liquefaction plants.

Process gas is scrubbed at 140 psig, with 15% monethanolamine to remove CO_2 and H_2S; gas leaving the unit is dehydrated and then compressed. A methane de-cycle system recompresses the recycling gases to 1500 psig and after introduction of 50 psig flash vapours the total recycle stream is further compressed and chilled. Methane storage facilities consist of flat-bottom double-walled umbrella-roof insulated tanks. Vaporization is accomplished by using propane as the heat transfer medium.

The economics of the process are illustrated by tables showing investment and comparative peak load shaving costs. The costs are subject to a 5% max contingency factor, and 7% annual average increase must be allowed for future proposed investment. G. A. C.

917. Treatment of Lacq gas. M. Berthier. *Chim. et Industr.*, 1959, **81**, 49–55.—Well-head gas (70° C, 470 kg/cm²) reduced to 30° C, 75/115 kg/cm² for transmission to treatment plant; glycol injection to prevent hydrate formation. Condensate high in aromatics, and for daily processing of 20 million m³ would yield annually (tons) benzene 2250, toluene 25,000, xylenes 31,400. Present plant treats 1 million m³ daily, using 20% diethanolamine to remove the 25% of acidic components (15 H_2S, 10 CO_2) in gas. Subsequently gas is dried

(Al_2O_3) and gasoline removed by absorption at −10° C. S from H_2S by Claus process. Analyses and flow sheets; delivered gas is 95+% CH_4, H_2S nil, organic S 2 mg/m³. New plant scheduled for 1959, 4 million m³/day, most of H_2S to be removed by H_2O wash at 70 kg/cm², residual gas, with 8% CO_2, 2% H_2S, will be treated by monoethanolamine, C_3–C_4 will be recovered by low temp separation. V. B.

918. Study and research on the production of town gas by chemical conversion of hydrocarbons. (In French.) C. Padovani. *Riv. Combust.*, 1959, **13** (1), 5–55.—The availability of raw materials and new techniques, as much as the accentuation of the peak-load problem, have given rise in the gas industry, notably in Europe, to considerable development in which the introduction of hydrocarbons as raw material for gas production, either as complete substitutes or as complementary to coal, may be considered to be most spectacular. Because of increasing vol of natural gas, one is induced technically to develop processes for producing, from different raw materials and with the max flexibility and economy, gases that may be substituted for other gases, according to modern criteria of interchangeability, namely: (1) gases of the natural gas type; (2) gases of the traditional town gas type.

Investigations and research work being carried out at the Stazione Sperimentale per i Combustibili cover the production of gas of two types, using either LPG or light petroleum dist.

The following operations have been appraised and tested: (*a*) continuous autothermal reaction, by means of a cat, of hydrocarbons in air/steam mixtures; (*b*) continuous endothermic reaction of hydrocarbons in air/steam mixtures; (*c*) cyclic endothermic reaction, by means of a cat, of hydrocarbons in steam; (*d*) homogeneous pyrolysis of hydrocarbons in the presence of steam.

By control of working conditions or combination of various processes, it is possible to produce gases of required composition, possessing combustion characteristics that render them interchangeable either with natural gas or traditional coal gas.

(Author's abstract.)

919. Natural gas; energy and raw material source for Italian industry. (In French.) C. Padovani. *Chim. et Industr.*, 1958, **80**, 639–54.—In 1956 natural gas provided 10% of Italy's energy. 1957 production 5×10^9 m³. Distribution through 4500-km pipeline system, use breakdown tabulated (main items: 64% as industrial fuel, 13% as fuel for electricity generation, 10% as domestic fuel, 5% as automotive fuel, balance mainly for chem synthesis). As fuel, 1 m³ gas = 1·4 kg coal, 0·9 kg fuel oil. Considerations governing use of natural gas for aforementioned purposes are discussed, with particular reference to future expansion of chem uses (oxidn to C_2H_2, conversion to CO and H_2, direct reduction of ores). 53 refs, mainly to Italian sources. V. B.

920. Growing world use of natural gas. Anon. *Petrol. Press Serv.*, 1958, **25**, 336–40.—In the free world outside the U.S.A. natural gas consumption—excluding reinjected gas—has increased *ca* 3·5-fold to approx 2200 ft³/day in 1957. The equiv on a cal basis—*ca* 19 million tons/pa of fuel oil—is small compared with total petroleum consumption ~350 million tons. A similar overall increase to 2500 million ft³/day has occurred in the Communist countries. U.S. consumption—still representing the bulk of world consumption—has increased by ⅔ to 29,000 million ft³/day in 1957, being 93% of total free world and 86% of whole world consumption. The contrast with the 55% share of free world oil consumption is attributable to the economic and political factors of pipeline transport of gas. In some countries natural gas is important as an energy supply. Discovery and development of natural gas in W Europe have increased consumption eightfold to *ca* 660 million ft³/day in 1957, ¾ of the increase being in Italy. Increase in natural gas consumption in W Europe was *ca* ⅔ of the total increase since 1950 in the free world outside the U.S.A. Considerable expansion has taken place in Canada following opening of the Westcoast Transmission Pipeline in 1957. Natural gas as a preferable alternative to manufactured gas has the advantage of a twofold cal val, and transport and storage advantage coupled with low well-head price—if available by pipeline at competitive prices to existing or potential markets—assure rapid increase in consumption. Speed of growth has been demonstrated in the U.S.A. (see *Petrol. Press Serv.*, 1958, **25**, 162). If success attends the forthcoming experiments in ocean transport of natural gas a new field will be opened up (see *Petrol. Press Serv.*, 1956, **23**, 262). In Venezuela—where much gas is flared—it is proposed to use it in steel works, power stations, etc. (see *Petrol. Press Serv.*, 1958, **25**, 290). R. T.

921. Foundations of future development of natural gas production. (In Polish.) J. Girzejowski. *Nafta* (*Krakow*), 1958, **14**, 43–6.—Before the 1939–45 war natural gas from Roztoki was supplied to the Central Industrial Region (near Sandomierz, the confluence of San and Vistula). The German exploitation of this deposit has lowered the pressure so much that this particular formation serves as an underground storage space for gas from Starochciny. Since the end of the war gas has been found in the Sanok region and the network of pipelines has been considerably extended. Now it consists of 1370 km of main lines and 231 km of branch lines. Other fields are of smaller importance. Gas is fairly pure and particularly free from sulphur, thus forming a particularly good chemical raw material. Its use as fuel for steam-raising has thus been disallowed. For domestic purposes it is used in 13 towns exclusively and partly in Warsaw, Krakow, Bielsko, and Radom. In the Tarnow region of supply consumption has risen from 31 million standard cu m in 1950 to 97½ million in 1956. This represents most indigenous gas supplies, which have more than doubled between 1950 and 1956–57, but the peak has been passed. Further deposits have not been found, and the growing demand leads to a deficit. The gap between supplies and potential market will reach 90 million cu m in 1961, rising to 700 million cu m in 1975. This can only be filled with gas from coal, which involves a much greater expenditure. On the balance of things, drilling for gas becomes the more economical. Likely deposits are in the Carpathian foothills. M. S.

922. Sixth Scientific Technical Conference on Gas Industry. (In Polish.) Anon. *Nafta* (*Krakow*), 1958, **14**, 51–3.—With the aim of raising the consumption of gas in Poland the Conference held in Krakow dealt with gas from all sources. Paper by F. Tysowski dealing with natural gas outlined future developments thus: While the total may rise from 528 million m³ in 1956 to 581 in 1960, it is likely to fluctuate about that figure between then and 1975. During that time indigenous resources are to fall to *ca* half of their present output and imported methane from the U.S.S.R. will rise from 135 to 300 million m³. Methane from coal mines is expected to rise from 1 to 80 million m³. Over the same period the chemical industry's share is to rise from 87 to 123 million m³, domestic consumers' share is to rise from 99 to 215 million m³, the rest being taken up by heavy industry (209–128 million m³), power production (55–19 million m³), and other consumers (76–95 million m³). Future new supplies, if the figure of 30,000 m³ of gas per drilled metre is maintained, should bring 800 million m³ in 1975, according to Obuchowski, whose figures are four times as high as those of Tysowski. They take into account gas consumed during these 20 years. Cost per heat unit for methane is only a tenth of the cost of Lurgi process. Other speakers agreed with the higher figures and stressed that the situation in the U.S.S.R. and Czechoslovakia has rapidly improved recently. M. S.

ENGINE FUELS

923. Ignition of fuel–air mixtures on hot surfaces. (In German.) B. Kaesche-Krischer and H. C. Wagner. *Brennst-Chemie*, 1958, **39**, 33–43.—Ignition temp for homogeneous mixtures are determined for sudden and uniform heating by adiabatic compression, or percussion waves, and heating by contact with a hot body. In a further procedure fuel is dropped, led, or sprayed into preheated air. These methods are discussed with numerous supporting diagrams. Gas ignition pt by the VDE and by the ASTM drop ignition method are compared, and their dependence on various parameters, container size, mixture composition, wall material, etc., is determined. Between the two methods particular differences arise if the material under investigation be capable of forming cold flames in which only part of the fuel is incompletely oxidized. Intermediate products are formed and equilibrium is not attained. 15 refs. R. T.

924. Exhaust fumes and smoke. Anon. *Auto. Engr*, March 1959, **49** (3), 110–11.—Methods employed by London Transport Executive to control and measure exhaust pollution are described. These include exhaust gas analysis using conventional Orsat apparatus, and the testing and setting of diesel injection pumps by means of the Leslie Hartridge machine. Exhaust smoke is surveyed usually every three months in Central London, 800 buses being involved. Tests to assess the merits of equipment for measuring exhaust smoke density have shown the Hartridge–BP design to be the most convenient to operate. A. D. S.

925. Fuels and lubricants for the Trans-Antarctic Expedition. D. L. Pratt *et al*. *J. Inst. Petrol.*, 1959, **45**, 19–40.—Fuel and lubricant requirements for the equipment of the Trans-Antarctic Expedition are outlined. Work which led to the choice of fuels and lubricants for tracked vehicles, aircraft, and generating equipment is described, and supply of materials for miscellaneous purposes, such as cooking and de-icing, discussed. Emphasis is placed on ways in which special requirements, dictated by the vehicle types used and the arduous conditions under which they operated, were met. Behaviour of equipment and materials at low temp and performance of fuels and lubricants under Antarctic conditions are reported. A. D. S.

926. Fractional composition of carburettor motor fuels. (In Polish.) L. Bednarz. *Nafta (Krakow)*, 1958, **14**, 69–73.—The author discusses the significance of the salient points in dist curve. For free starting $t_{10\%} \leqslant 1{\cdot}25\,(t_{\text{motor}} + 59)^\circ$ C and to avoid vapour-locks $t_{10\%} \geqslant (0{\cdot}5\ t_{\text{tubing}} + 46{\cdot}5)^\circ$ C. Furthermore, the average temp of the fuel, t_{av}, should be related to $t_{50\%}$, which approx equals $(2\,t_{\text{av}} + 18)^\circ$ C. The article gives a comparison of dist specifications for gasoline according to Polish PN-56/C-96025, Soviet GOST 2084–56, U.S. ASTM, Federal Germany's DIN-51600, Czechoslovak CSN 656505, Jugoslav JUS BH 2220, Rumanian STAS 176–53, South African SABS 299–1951, and also the relationship between ON and boiling range specifications for various kinds of fuel. In conclusion, the author considers Polish specifications to be insufficiently differentiative towards seasons and climatic variations. M. S.

GAS OIL AND FUEL OIL

927. Residual oils present burning problems. G. T. Kaufman. *Fuel Oil & Oil Heat.*, Sept 1958, **17** (9), 97.—Problems arise due to varying burning characteristics of residual oils and lack of reliable methods of measuring these characteristics. The most undesirable characteristic of these fuels is the formation of a dry powder coke-like material left on combustion, which has been given the name fly-carbon. The formation of sludge is considered, together with the use of additives to alleviate it. The behaviour of carbon particles in the combustion zone is also discussed. It is thought there is a relationship between the fly-carbon formed in boilers and carbon residue in fuel oil. Remedies for fly-carbon are also considered. D. K.

928. Towards pulsation-free combustion. J. W. Schulz. *Fuel Oil & Oil Heat*, Nov 1958, **17** (11), 58.—An explanation of oil flame pulsation put forward by E. K. Smith of the Hart Heat Division of Avery Farm Machinery Co, Peoria, Illinois, is considered. It is suggested that the pulsating flame is the result of two opposing forces. First, the spray of atomized fuel oil gains control of the flame shape, next the combustion air entering the fire box at high velocity forces the flame to be a different shape related to the air pattern formed by the gun-tube air-handling parts. Each change in flame shape can produce compression or expansion in the combustion chamber, hence the pulsation. The remedies for pulsation in current use are discussed. Mr Smith suggests a new type of combustion head, wherein the combustion air enters the firebox at low velocity so that the flow of air does not influence the shape of the flame. The injection or aspiration method is used to have the atomized oil draw slow-moving air into the path taken by the oil. This must occur at the proper place in the firebox, *e.g.* 3 inches from the orifice of the atomizing nozzle. Burners which fire 0·65–1·65 gph have been designed on this principle, and their operation is discussed. D. K.

929. Problems encountered with the use of high sulphur content fuel oils at Marchwood Generating Station and experience with chemical additives. T. J. Wilkinson and D. G. Clarke. *J. Inst. Fuel*, 1959, **32**, 61.—The problems encountered were: corrosion of low temp air-heaters, severe attack on the precipitator concrete and insulators, grit arrestor blockage, ducting corrosion, and acidic products in the stack. Between July 1957 and June 1958 experiments were made with ammonia, two proprietary powder additives, dolomite, pyridine, Mg_2CO_3, and carbon monoxide (town gas). Relative merits of the additives are discussed.

Modification to the boilers to improve combustion conditions and apparatus developed in conjunction with the additive tests are also described. D. K.

930. Some contributions to fuel economy in the electric power industry. F. R. le Pla. *J. Inst. Fuel*, 1959, **32**, 14.—Some methods adopted to achieve fuel economy are: (1) using low grade coal and oil; (2) siting of power stations; (3) improving steam-raising plant; (4) improving the design of electrical generating plant; (5) introducing nuclear power. Each is discussed separately. D. K.

LUBRICANTS

931. Harmful effects of electrostatic charges on machinery and lubricating oils. T. Salomon. *J. Inst. Petrol.*, 1959, **45**, 47–68.—A number of incidents of abnormal behaviour of turbine oils due to electrostatic charges created within the turbine are surveyed. It is concluded that such charges, which can be produced during the lubrication of machinery, play a significant part in the lubrication process, particularly in the formation of oil films and in pitting wear. The concept of a shock wave as being the primary cause of wear is presented. It is pointed out that the usual interpretation of the ohmic resistance of an oil film as a means of measuring film thickness does not take sufficiently into account the special dielectric properties of thin oil films. Such films can, under certain conditions, behave as perfect electrical conductors. A. D. S.

932. Supplement I oil. Anon. *Auto. Engr*, March 1959, **49** (3), 107–9.—Tests with 13 engines carried out on SAE 20 and L

10W/30 straight mineral oils and additive-containing oils to Supplement I level of performance proved the value of additives in increasing engine cleanliness and reducing wear. These tests highlighted certain inherent weaknesses of mechanical design, such as the need for tougher bearing materials of the lead–indium, aluminium–tin, and copper–lead type. There was evidence of poor pressure distribution on pistons, and with two engines some parts were found to be outside manufacturers' tolerances. A. D. S.

933. Viscoelasticity in lubrication. G. J. O'Donnell. *Mech. Engng, N.Y.*, 1959, **81** (2), 63–5.—Under high loads when plastic flow can take place on spur-gear teeth, lubricants can prevent metal-to-metal contact, and it is hypothesized that the viscoelastic properties of the lubricant and its relaxation time are part of the explanation. Viscoelastic substances are defined as those which respond to shear stresses both as normal viscous liq and as elastic solids. Relaxation time is the ratio of visc to shear modulus, and theory predicts that it is of the order of 10^{-6}–10^{-8} sec for mineral oils, silicones, and diesters. The effect of single and multiple stresses on the displacements produced and the possible effects of the properties of a viscoelastic lubricant on load-carrying capacity of a very high-speed, heavily-loaded journal bearing are discussed. The lack of fundamental data for calculating the effects of viscoelasticity in lubrication problems is emphasized. A. D. S.

BITUMEN, ASPHALT, AND TAR

934. Bitumen in mineshaft construction. (In Dutch.) R. E. Kerkhoven. *Ingenieur, 's Grav.*, 20.2.59, **71** (8), B29.—Two concrete shafts with a 10-cm bituminous layer between lining and soil have been built by the Dutch State Mines. The advantages, material requirements, and methods of application are discussed. Based on the knowledge of mech properties of bituminous material, it is possible to design the right type of bitumen for given requirements. Actual examples are discussed in detail. The method of application is dependent on the method used for building the mine shaft. 11 figs, 7 tables. G. F. T. C.

935. Contribution to the technique of bitumen emulsions. (In German.) H. Nüssel and A. Buhs. *Bitumen, Teere, Asphalte, Peche*, 1958, **9**, 33–8.—Some of the factors especially important for the production and practical application of emulsions, visc, stability, etc., are treated according to the state of the latest knowledge. 27 refs. (see Abs. **2241**, 1957; **283**, **494**, 1958). R. T.

936. Viewpoints for bitumen evaluation. (In German.) D. C. Broome. *Bitumen, Teere, Asphalte, Peche*, 1958, **9**, 40–3.—A critical discussion of the imperfections of bitumen specifications in many lands is presented. Reasons why conventional test methods do not give the desired and adequate information are explained, and procedures for remedying the defects are discussed. R. T.

937. Asphalt, bitumen, and pitch varnishes as bituminous coatings. (In German.) M. Böttcher. *Bitumen, Teere, Asphalte, Peche*, 1958, **9**, 9–14.—A review of the origin, composition, and properties of asphalts, bitumens, and pitches and their application as varnishes, with special ref to the patent literature. 65 refs. R. T.

938. Coloured poured asphalt in building above ground. (In German.) G. Jentzsch. *Bitumen, Teere, Asphalte, Peche*, 1958, **9**, 7–9.—Advantages and weaknesses of coloured poured asphalt are discussed. Red-brown is the colour mostly favoured; pure brighter colours are difficult to obtain. Coloured poured asphalt is suitable for floors subjected to much traffic, *e.g.* cinemas, waiting rooms, etc. The laid material resembles a linoleum flooring. R. T.

939. Tar in town road building. (In German.) — Winterschnitz. *Bitumen, Teere, Asphalte, Peche*, 1958, **9**, 3–6.—A general discussion is presented on the use of tar binders in road surface covering, the effects of traffic on newly treated surfaces, and properties of thin and thick surfaces. Sp advantages of tar and bitumen are combined in suitable mixtures to obtain max efficiency. Lab experiments carried out in Stuttgart with two tars of different visc with and without Pulvatex pure rubber powder additions are reported. Both tars show that rubber addition produces no change of gross wt; H_2O absorption and swelling are lowered. With increasing binder cont cohesion increases at first, then decreases. However, val for tars with rubber addition, as a result of higher visc, are at first higher. The angle of internal friction decreases with both tars with increasing tar addition. Fluctuations in binder addition, when using rubber additions, do not produce such an unfavourable result as is observed with tar alone. R. T.

SPECIAL HYDROCARBON PRODUCTS

940. Electrical breakdown of liquid insulators. (In Dutch.) J. A. Kok. *Ingenieur, 's Grav.*, 13.12.57, **69** (50), 179.—The electrical breakdown strength of insulating oils depends on the size of foreign particles which may form bridges in a place of max electric stress. This theoretical relation was verified with colloid suspensions of particles of known radius. Mineral oils may deteriorate by flocculation, which depends on the relative magnitude of the attractive London–van der Waals forces and the repulsive Coulomb forces. The possibility of using mineral oil as an insulator depends on the existence of an upper limit of the size of the particle aggregates due to the rapid fall off of the London–van der Waals forces at dia exceeding 500 Å. (Author's abstract.)

941. Experiment and theory of electric breakdown of liquid insulators. (In Dutch.) J. A. Kok. *Ingenieur, 's Grav.*, 5.7.57, **69** (27), E87.—Polarizable material drifts towards a place of max stress under the influence of a transverse field gradient. For a given field strength and temp there exists a critical particle size above which the particles will join together and form a bridge. Theoretical derivation and examples are given. The breakdown strength of Shell Diala oil was increased considerably by purification in an electrostatic Cottrell filter. 7 figs, 4 photographs. G. F. T. C.

DERIVED CHEMICAL PRODUCTS

942. Synthesis of benzene derivatives from petroleum. (In French.) H. G. McGrath. *Chim. et Industr.*, 1958, **80**, 561–7.—Rate of production is increasing, U.S.A. forecast for petroleum derived materials for 1960 is (metric tons) benzene 6 million, toluene 11·5 million, xylenes and ethylbenzene 14·5 million. Hydroforming and cat reforming reactions are described and efficiency of Pt, Mo, and Cr cat compared relative to nature of feed and of benzene yield. Main process is based on Pt, but as aromatics consumption increases synthesis of benzene from *n*-hexane and *n*-heptane will be required, involving a change in the Mo/Al_2O_3 or Cr/Al_2O_3 cat. (Author's summary.)

943. Ten years of petroleum chemicals in Britain. H. Steiner. *Petrol. Times*, 10.4.59, **63**, 299.—With the exception of the U.S.A., the petrochemical industry in Britain is the largest of its kind in any country. *Ca* 1,300,000 tons of raw material, mostly naphtha, were used in 1957, and 230,000 tons of ethylene produced.

A review is given of the plants, their types, and capacities from 1952. By 1958 there was a considerable diversification of products. The outstanding British discovery and development is the polymerization of ethylene to polyethylene, and

the manufacture of Terylene fibre from two components of petroleum origin is notable. A table shows production figures for 1957, 1958, and an estimate for 1960. G. A. C.

COAL, SHALE, AND PEAT

944. New investigations on peat pyrolysis. (In German.) W. Naucke. *BrennstChemie*, 1958, **39**, 21–6, 43–53, 74–84.—Pt 1. Progress in the knowledge of peat pyrolysis is reviewed in a sequence of works during the last 20 years. The manifold influences of a purely material, physical, and technical nature—raw material, composition, procedure, etc.—on which peat pyrolysis results depend are discussed. Data presented—possessing no claim to general validity—are valid only for the test conditions given in the cited literature. The compilation of the influences described is valuable as a qualitative guide to peat low-temp carbonization. By keeping the given factors const the influence of low-temp carbonization on peat pyrolysis can be described as quantitatively as possible by observing the effect on structure and properties of the resulting coke. 33 refs.

Pt 2 describes the experimental conditions of peat pyrolysis. Analytical treatment of the decomp reaction yields information on the influence of factors—temp, material composition, etc.—on the course of the pyrolysis. The data are valuable as criteria for influencing the pyrolysis and the coke properties. A general observation of the pyrolysis with the help of van Krevelen's statistical structural analysis and physical-chem investigations is presented. Numerous charts. 28 refs.

Pt 3. Evaluation of the electron diffraction diagrams of peat coke of different production temp shows that peat pyrolysis can be characterized by the following main phases: up to *ca* 76% C (400° C) primary decomp; up to *ca* 89% C (*ca* 550° C) primary + *sec* decomp, extensive formation of a polycondensed system, aromatically combined C-epds with relatively many bridges and gaps in the crystal lattice; up to *ca* 91% C (*ca* 725° C) part carbonization of the polycondensed aromatic system and beginning of disordered C-rich crystals in partly graphitoid turbostratic arrangement; *ca* 91–96% C (up to *ca* 1200° C) carbonization; formation—preferably in the direction of the *c*-axis—of an orderly, turbostratic presentable graphitoid lattice. Above 96% C (up to *ca* 2600° C) heterogeneous graphitization. Formation also in the direction of the *c*-axis of orderly graphite crystals. Only part of the substance graphitizes, the rest remains less orderly. Numerous diagrams, photographs, and tables. 31 refs. R. T.

CORROSION

945. High-temperature hydrogen sulphide corrosion in refinery experience. P. W. Sherwood. *Corrosion Tech.*, 1958, **5**, 326–9.—Attack by H_2S has become serious with the introduction of high temp cat processes. The important effects are loss of metal and the formation of large quantities of scale; the most important factors are concn of H_2S and temp. Cr–Ni steels show good resistance up to 900° F, and Al coatings also show excellent resistance. Complete desulphurization of the feedstock is in general too costly, but the corrosion can be greatly reduced by removal of H_2S from the recycle gas. G. B.

946. Some aspects of refinery corrosion due to crude oil. P. W. Sherwood. *Corrosion Tech.*, 1959, **6**, 10–12.—The corrosive agents considered are chlorides, water, acids, and sulphur. The methods of control are dehydration, desulphurization, and neutralization with NH_3, NaOH, or Na_2CO_3 for low temp, CaO for high temp, and naphthenic soaps or triethanolamine in special circumstances. G. B.

947. Corrosion in catalytic reforming and associated processes. E. B. Backensto. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 87–92.—A survey of 31 companies, representing experience on all types of commercial cat reforming units and desulphurizers which use hydrogen, revealed that the most frequently encountered difficulties related to corrosion were excessive metal loss; heavy scaling of furnace tubes, exchangers, and/or transfer lines; plugging of catalyst beds; and fouling of heater and exchanger tubes. The most widely used methods to combat and/or control corrosion are proper alloying, generally with 18–8 chromium–nickel stainless steel at high temp; feedstock desulphurization; hydrogen sulphide removal in recycle gas; and aluminizing.

Without exception, all companies stated that their corrosion experience with cat reformers agreed generally with that described in recent literature. (Author's abstract.)

948. Some typical cases of corrosion in Platforming units. D. J. Bergman and S. A. Bjorkman. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 93–9.—The paper covers cases of corrosion encountered in UOP Platforming units at several locations. Particular emphasis is placed on heater tube corrosion, intergranular corrosion of stainless steel valve trim in cold zones, and stress corrosion of Monel impellers in centrifugal recycle-gas compressors. (Authors' abstract.)

949. Corrosion control in Ultraforming. A. Dravnieks and C. H. Samans. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 100–15.—Control of sulphidic corrosion in Ultraformers is desirable to increase equipment life and to prevent build-up of pressure drop across the cat bed because of dislodged corrosion products. Data on the corrosivity of hydrogen sulphide bearing streams have been obtained, in lab and in plant tests, as a function of hydrogen content, temp, and pressure. The effect of chromium content of the steel has also been studied. The correlations obtained in this work permit an approx prediction of corrosion rates under unit-operating conditions. Experience shows that satisfactory operation from a corrosion viewpoint can be secured by proper control of the ratio of hydrogen sulphide to hydrogen of the vapour stream, by the separation of naphtha and hydrogen bearing streams, by selection of suitable alloys and/or coatings, and by the use of inhibitors. (Authors' abstract.)

950. Corrosion in crude oil processing—low pH *v.* high pH. J. A. Biehl and E. A. Schnake. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 129–34.—This paper summarizes the operation and corrosion of a crude oil unit at high pH and low pH control of overhead receiver waters. The corrosion and operational after-effects of the unit's operation at an average pH of 7·5 in receiver waters, with 6–10 ppm of inhibitor injection in vapour overhead, resulted in studies directed towards minimizing these problems. The studies resulted in the reduction of the pH of receiver waters to an average of 4·3, with inhibitor injections varying from 10 to 15 ppm. After 27 months of operation under these conditions after-effects have been eliminated, and corrosion data indicate excellent protection of equipment. (Authors' abstract.)

951. Hydrogen attack of steel in reformer service. A. R. Ciuffreda and W. D. Rowland. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 116–28.—A recent case history is discussed in which three internally insulated carbon steel reformer reactors suffered permanent damage by hydrogen in approx one year. The attack varied in severity and location, depending upon metal temp. Investigations indicated that a transition

period exists for hydrogen attack, during which carbon steel suffers permanent hydrogen damage, with no evidence of this shown in the micro-structure. (Authors' abstract.)

952. Pipelines' corrosion quiz. G. Kinney. *Oil Gas J.*, 16.3.59, **57** (12), 173.—Practical answers are given to 17 questions on corrosion asked at the 10th annual Tulsa Corrosion Short Course, and included effect of frozen ground on soil resistivity and soil potential surveys, spacings in soil-resistivity tests, economics of installing anodes on a service connexion, prevention of interference with neutral systems, and max pipe-to-soil potential without causing damage to the coating. G. A. C.

953. High-nickel alloys in the petroleum industry. G. L. Swales. *Corrosion Tech.*, 1959, **6**, 81–4, 119–23.—Pt 1. Structures exposed to salt spray can be protected by cladding with Cu–Ni alloys of high Ni content. Hard alloys of similar types with good tensile strength can be used for the construction of pumping equipment in wells producing highly corrosive crude and for non-magnetic drilling collars. Refinery plant subject to high temp corrosion by S cpds and naphthenic acids can be clad with Cu–Ni alloy or constructed of high-Ni steel. In Pt 2 specific refinery corrosion problems are discussed. These include HF alkylation, H_2SO_4 alkylation, acid treatment, isomerization, amine treatment to remove H_2S and CO_2, furfural extraction, and high temp corrosive conditions such as exist in furnaces. The types of Ni alloy suitable for these applications are described. A table showing the composition of Ni alloys is given. G. B.

954. Pipeline protection in the Middle East. Pt 1. Protective coating and cathodic practice. L. R. Sparrow. *Corrosion Tech.*, 1959, **6**, 13–18.—The types of aggressive soil and the atmospheric conditions encountered in the Middle East are discussed in relation to the measures taken to combat corrosion. The normal practice is to use both coating and cathodic protection. The most usual coating system is a hot coat of asphalt with a paper wrapping. Additional mechanical protection is applied where necessary. G. B.

ENGINES AND AUTOMOTIVE EQUIPMENT

955. The development of return burners. (In Dutch.) B. J. Voslamber. *Ingenieur, 's Grav.*, 17.10.58, **70** (42), 151–8.—Return burners (*e.g.* the Bargeboer burner) have been developed to obtain better furnace control. The system works efficiently on a stationary installation and the paper gives a detailed description of its performance on naval craft. 9 figs, 6 refs. G. F. T. C.

956. An automatic engine test bench. (In Dutch.) Anon. *Ingenieur, 's Grav.*, 27.8.58, **70** (34), V51.—A versatile automatic test bench is described on which the behaviour of a car engine on the road can be closely and reproducibly simulated. Some construction details are given and the operating characteristic of the control system illustrated. (Author's abstract.)

957. Air pollution by motor vehicle exhaust. (In Dutch.) M. J. van der Zyden. *Ingenieur, 's Grav.*, 8.8.58, **70** (32), 39.—Means of preventing air pollution by petrol engine exhaust are proposed, *e.g.* good maintenance and adjustment of the engine, improved carburation, reduction of fuel flow during coasting, fuel injection instead of carburation, and treatment of exhaust gas in an after-burner. Main causes of diesel smoke are insufficient maintenance, overloading, low engine temp during idling periods. Exhaust filters and after-burners for diesel have not yet been fully investigated. One fig. G. F. T. C.

958. Vigom process. R. Vichnievsky. *Bull. Ass. franç. Tech. Pétrole*, 1958, 641–53.—This process, developed by IFP, originally for military purposes, enables CI engines to operate on wide range of fuels and consists of modification of fuel injection pump camshaft whereby fuel is injected in two stages, part into hot residual gases a few degrees before closure of exhaust valve, and remainder at end of compression stroke. Test results on various engines for both gasoline and gas oil are tabulated; civilian possibilities include use of wider boiling range fuels and smoother running, especially at low speeds. V. B.

SAFETY PRECAUTIONS

959. Protective gas in the mineral oil industry. (In German.) A. Foulen. *Chem. Z.*, 1959, **83**, 88–9.—The oil industry does not need high purity nitrogen for the production of protective gas blankets. An apparatus is described which burns a mixture of air and hydrocarbon gas to produce between 10 and 2000 m^3 of a suitable gas under a pressure of *ca* 1·5 atm. Provision can be made for washing the gas to remove CO_2. P. J. K.

ECONOMICS AND MARKETING

960. Petroleum trade of the United Kingdom in 1958. Anon. *Inst. Petrol. Rev.*, 1959, **13**, 72–4.—Total imports of crude petroleum and liq petroleum products into the U.K. were 11,672·9 million gal in 1958 according to the official preliminary report. This was an increase of 15·5% over the total for 1957, which was affected by the Suez crisis, and of 17·9% over 1956. Details for individual products are tabulated, and of the total quantity 8787 million gallons was crude and partly refined petroleum. Imports of petroleum and petroleum wax decreased compared to 1957. Cif values of imported oils showed a general decrease for 1958. Analysis of countries consigning petroleum to the U.K. revealed the return to normal after the Suez crisis. The substantial increase in 1958 exports of U.K.-produced liq petroleum products over 1957 was partly accounted for by the increased sales of gas oil. A. D. S.

961. U.S. refining capacity to hit a plateau this year. L. Resen. *Oil Gas J.*, 30.3.59, **57** (14), 112.—The survey, which shows that capacity will level off at *ca* 10 million bd, includes all facilities which were in operation in Jan 1959, and is restricted to plants charging whole crude oil. Capacity rose 6% in 1958, hydrogen treating is expected to rise only 6·2% in 1959, cat reforming 4·8%, cat cracking 2·4%, whilst alkylation will gain *ca* 6·3%. An appendix gives 13 speciality plants producing asphalt, lub oils, wax, and fuels. G. A. C.

962. Annual survey of capacities of United States operating refineries. Anon. *Oil Gas J.*, 30.3.59, **57** (14), 117.—Location and capacities of refineries in the U.S.A. are tabulated, and it is shown that capacities were increased to more than 10,150,000 bsd by 1.1.59. Ownership of refineries is stated. G. A. C.

963. Annual survey of Canadian operating refineries. Anon. *Oil Gas J.*, 30.3.59, **57** (14), 144.—Location and capacities of refineries in Canada are given. Crude capacities increased from 818,000 bd at 1.1.58 to 886,000 bd at 1.1.59. Ownership of refineries is listed. G. A. C.

964. Survey of new refinery construction. Anon. *Oil Gas J.*, 30.3.59, **57** (14), 152.—Refineries scheduled for completion after 1.1.59 in the U.S.A. and Canada are listed in alphabetical order. Ownership, estimated completion date, and type of units are stated. G. A. C.

965. The post-war pipeline boom. Anon. *Petrol. Times*, 10.4.59, **63**, 301.—Some reasons for Britain's failure in the pipeline industry are given. Since 1946 the industry has developed to such an extent as to have become one in its own right. Pipeline growth in recent years has been most rapid in Canada, with the U.S.A., the Middle East, and Europe following. Apart from pipeline construction by the Gas Boards in Gt Britain, little else has been done.

Little has been done to capture the lucrative Middle East market; on any pipeline project the equipment will be mainly American. British manufacturers are reluctant to invest capital in the specialized equipment necessary, and have thus lost on the best markets. G. A. C.

966. Economic effects of gas export on Alberta. H. Harries. *Canad. Min. metall. Bull.*, 1958, **51**, 427–30.—This study—based on projects currently planned, under construction, or in operation—indicates developments which will follow from a gas export level from Alberta and NE British Columbia greater than the current one. Five years hence these projects will be providing an annual market for 594 billion ft^3 of Alberta and British Columbia gas, or 3·5 times the amount marketed in 1956 in Alberta and British Columbia. An economic analysis shows the far-reaching effects of such projects. The economic future of the area can be affected profoundly by changes in incomes, prices, and consumption patterns created by these projects. Factors related to the export projects have varying effects on the area's locational pull and industry-attracting ability. Analysis shows *ca* $1448 million spent on pipelines, gathering systems, finding new reserves, etc. This is approx $370 for every Canadian family within a ten-year period. The vital portion—estimated at $695 million—is that spent within the Province. Allowing for payments to outsiders, *ca* $330 million will become a primary or direct income source to Albertans as wages, royalties, dividends, and interest payments. The total primary income of $855 million is estimated to become $1795 million total income for the ten-year period. This extra income, averaging $155/person/year, will be reflected in population growth. Provision of market outlets and competition between buyers will tend to raise the price of gas, previously a cheap distress product on a glutted market. Inflation will affect the price of gas, which could be exported to advantage. Increase in gas price will occur and will decrease its competitive advantage or eliminate it entirely. Industrial firms using natural gas as raw material will not change. Some industries, *e.g.* petroleum refining, may change their fuel source. R. T.

967. Morocco in Persia's footsteps. Anon. *Petrol. Press Serv.*, 1958, **25**, 334–6.—The new Royal Decree on petroleum of 21 July 1958 is based on the Persian pattern, adhering to a 50/50 division of profits between commissionaire and state, but provides for—and favours—partnership between oil companies and state. A further similarity is an agreement with Italian state-owned AGIP Mineraria (see *Petrol. Press Serv.*, 1958, **25**, 313), whereby the latter will bear all exploration expenses if no oil be found. The Moroccan state and AGIP will form a joint operating company on a 50/50 basis. Fruits of commercial oil discovery will be shared. Thus the state as shareholder will have—in addition to its taxation of net profits—half of the operating company's share of the profits. Moroccan law lays down the usual provision that hydrocarbon deposits are state property. The country is divided into three zones with special arrangements for exploitation, licensing, and taxation. At first non-exclusive reconnaissance permits are granted. These are followed by grant of search licences valid for 4 years, during which time an appropriate minimum exploration time is obligatory. On oil discovery the holder is entitled to an exploitation concession. Competitive bids for licences will carry preference to the most attractive bidder. Special taxation allowances are made when the company accepts government partnership. Only two companies have been active so far in Morocco. Oil production rose in 1954, but declined considerably in 1956 and 1957. Gas production declined also during this period. Eventual construction of a 1,300,000-ton refinery is under negotiation. There are still considerable sedimentary areas in Morocco meriting search. R. T.

968. The Sudan Petroleum Resources Development Act. Anon. *Petrol. Times*, 27.3.59, **63**, 196.—The Act, which came into force at the end of 1958, requires all aliens or foreign companies applying for licences or leases to incorporate companies in the Sudan for the purpose; provides for acquisition of 30% of their new capital by Sudanese; and makes no special provision for settlement of legal disputes.

The act lays down cardinal principles regarding ownership, exploration, and boundaries, and provides for the constitution of two government authorities, one to control development and use, and the other to set up a board at technical level.

The usual requirements regarding financial and technical capacity of the applicants are defined, and the licence confers right of exploration and right to apply for a lease in respect of discovery.

Lessee's dues are defined, and include an annual rent in advance of £S60/sq km or part of the lease area and a royalty on a defined basis. Rights and easements over land, relief, and immunities are stated, as well as offences and penalties. It is concluded that the law is simpler and more straightforward than similar legislation elsewhere, but it does give possibility of a 70% share of profits to the State after 10 years production by a company. G. A. C.

969. The U.S.S.R. in the world raw material market. (In German.) Anon. *Chem. Ind.*, 1959, **11**, 61.—In a review of the U.S.S.R.'s position as a producer and exporter of raw materials, figures are given for oil production and export in 1957. P. J. K.

970. The competitive German market. Anon. *Petrol. Press Serv.*, 1958, **25**, 330–3.—W Germany's prosperity is reflected in recent rapid increases in inland consumption of petroleum products. Inland consumption of all products doubled during 1953–56 and rose in 1957 by a further 12% to *ca* 14 million tons. Estimated consumption for 1958 is 16¾ million tons and 32½ million tons by 1965. Prospect of rapid advancement has attracted investors, and considerable new capital investment is contemplated. Fuel oil—the most dynamic section of the German oil market—is expected to account for >7½% of the total inland oil trade by 1965. The result of severe competition between fuel oil distributors, and between fuel oil and coal, has been a big fall in the for price of Grade C fuel oil. Ruinous price competition has troubled the

Government, and protection for the coal industry has been suggested. Consumption of motor gasoline and gas diesel oils—sales were virtually equal in 1957—is rising steadily. Selling of motor fuels has also become highly competitive in price, especially as regards gasoline in the S and SE parts of the Federal Republic, where low-priced imports from Italy and E Germany are offered. The Government's road building problem will increase bitumen demand, and aviation will require rising quantities of turbine fuel. Refinery capacity will increase from 16·6 million to *ca* 22 million tons in 1958, and to 40 million tons by the middle 1960s. Refinery throughput is $\frac{1}{3}$ indigenous and $\frac{2}{3}$ Middle East and Venezuelan crude. A rapid extension in output has occurred, but the advance is bound to decline (see *Petrol. Press Serv.*, 1957, **24**, 307). The economics of crude oil production in W Germany may be affected by the fact that the duty protection—incompatible with the EEC—may be abolished by Jan 1965, and may be substituted by state assistance (see *Petrol. Press Serv.*, 1957, **24**, 403). R. T.

971. Modern oil law for Spain. Anon. *Petrol. Press Serv.*, 1958, **25**, 329–30.—Spain—convinced that her restrictive oil legislation is old-fashioned—has introduced a Bill removing restrictions on foreign capital and embodying the 50/50 profit-sharing principle accepted in the world's main petroleum countries. Under this Bill foreign capital is admitted now without restriction up to 100% participation, and provision is made, within certain limits, for the availability, transfer, and convertibility of foreign exchange. Concession grant is discretionary, and applicants must prove their technical and financial competence. Foreign companies must become domiciled in Spain, and all disputes re the concessions are subject solely to Spanish courts. Exploration concessions will be granted for limited periods, with provision for extensions on reduced areas, and will be convertible on oil discovery into development concessions. Half the original area must be relinquished then in favour of the State, affording the latter blocks of near-proven territory which it may develop or put up to auction. Development concessions, valid for 40 years, with possible 10 years extension, oblige the producer to give priority to the Spanish market's needs, excess quantities being freely exportable. Operators may erect refineries for export and, with authorization, may refine also for the Spanish market if other refining capacity be inadequate. The State Petroleum Monopoly for petroleum product importation and inland distribution is not affected. Spanish oil consumption now approaches 4 million tons (see *Petrol. Press Serv.*, 1958, **25**, 56), all of which is imported. Standard procedure is laid down for profit division. Two promising areas exist, one the Ebro basin in the N, the other in the W, where sedimentary areas favour oil accumulation. R. T.

972. World-wide oil report. Anon. *Oil Gas J.*, 29.12.58, **56** (52), 87.—An indexed summary is given of reserves, production and drilling wells, production, and refining capacities for the world's oil countries. Detailed figures for Latin America, Europe, Middle East, Far East, and Africa follow on subsequent pages 89–144 inclusive. G. A. C.

MISCELLANEOUS

973. Medium size oil firing units. Anon. *Engineer, Lond.*, 1959, **207**, 72.—Description (photo) of two-component units in range $4{\cdot}5 \times 10^5$ to $3{\cdot}3 \times 10^6$ Btu/hr (fuel rate 36–260 lb/hr, 200 sec) electric air compressor (6–8 psig) specially silenced, pneumatic cut-off to close oil flow if air pressure fails; printed circuit links motor starter, heat motor, and flame failure relay; electrically preheated reservoir provides fuel for quick start from cold. V. B.

974. High level of refinery expansion. Anon. *Petrol. Press Serv.*, 1959, **26**, 49–52.—New refinery capacity planned in the free world, excluding N. America, amounts to 156 million tons pa, comprising 36 refineries building, 15 new plants awaiting final decision, and 29 schemes for extensions. This new capacity is mainly concentrated in importing and consuming countries. Tables are presented showing the location and the stage reached for each project, with the name of the company and the designed capacity. G. B.

975. The mineral wealth of Syria. (In German.) M. Y. Haschmi. *Chem. Z.*, 1958, **82**, 892–3.—In a review of the mineral resources of Syria, reference is made to the oil and asphalt industries. P. J. K.

976. Survey of the French petroleum chemicals industry. Anon. *Bull. Ass. franç. Tech. Pétrole*, 1958, 607–14.—Plant investment, 2×10^{10} fr end 1956, will increase by further 10^{11} fr by end 1959. In 1956 90,000 tons liq petroleum products and 260,000 tons refinery gas used for petrochem, by 1960 production of basic hydrocarbons est at 332,000 tons (olefins 292,000, aromatics 40,000). Map showing location of existing and projected plants, and products therefrom. V. B.

977. New plan for the reconstruction of the French chemical industry. (In German.) A. Ratty. *Chem. Ind.*, 1958, **10**, 291–4.—In a review of the plan for the reconstruction of the French economy the role of the petroleum industry is discussed. Particular reference is made to the importance of the source of natural gas at Lacq, near Bordeaux, the world's most valuable supply. P. J. K.

978. Current news. (In Polish.) Anon. *Nafta* (*Krakow*), 1958, **14**, 88.—Crude production for 1957 reached 180,691 tons, 3·8% more than expected. Natural gas produced reached a total of 417,761,000 m³. Production of natural gasoline (by stripping) was 16,483 tons. Both figures exceed plans by 1·9 and 1·1% respectively. M. S.

979. Steels for the petroleum industry. A comparison of British and American qualities. Pts 1 and 2. F. A. Kirk and J. Williams. *Corrosion Tech.*, 1958, **5**, 316–18, 357–60.—Pt 1. The special conditions in the petroleum industry call for steels resistant to industrial and marine atmospheres, high press steam, H_2S and SO_2 and with high tensile strength at high temp. The alloys recommended include 5–9% Cr–Mo grades for resistance to scale formation up to 700° C, the same alloys with Ti and Nb for improved annealing properties, and high Cr and Cr–Ni steels with a range of C content to give a choice of hardening properties. Addition of 0·2% Al to 13% Cr alloys with 0·12% max C minimizes hardening at welds. In Britain, S, and in the U.S.A., Se, is added to confer machinability. The behaviour of these alloys on heat treatment and welding and the significance of their properties are discussed.

Pt 2 deals with austenitic steels with additions of Ti, Nb and Ta, and Mo, with 25–12 and 25–50 Cr–Ni steels, and special alloys, including high Mn and pptn hardening austenitic steels and martensitic steels, and with the specifications covering them. Although the ASTM, AISI, and BSI specifications are not equivalent, British steel makers supply grades to meet all the specifications discussed. G. B.

980. Petrochemistry. IV. Items of interest from the techniques of mineral oil. (In German.) E. Boye. *Chem. Z.*, 1958, **82**, 534–8.—A review of the German oil industry and its relation to the world position. Figures and diagrams show how the production of oil has varied during the years, with emphasis on the post-war period. P. J. K.

BOOK REVIEWS

More Studies in Early Petroleum History, 1860–1880. R. J. Forbes. Leiden: E. J. Brill, 1959. Pp. 199.

In this second series of essays on the early history of petroleum, Professor Forbes continues and expands some of the themes brought forward in the previous volume. The present volume is dedicated to the Fifth World Petroleum Congress, to be held in New York in 1959.

Although the title refers to 1860–80, many of the articles are of much earlier date, and the first gives an interesting account of Pierre Belon in the sixteenth century, who presents a much more complete survey of crude oils at that period than is given in the more widely known book of Agricola. This work is compared in the second chapter with that of a contemporary pharmacist, Mattholus. These two chapters lead on to a general survey of the literature of the work on the composition of petroleum.

The use of petroleum in warfare is dealt with next, going back to the Iliad and more particularly to Herodotus. The use of petroleum continued to develop until the explosive force of gunpowder replaced it.

One especially interesting chapter deals with the use of "oil for millions of lamps," giving a full account of the work of Argand and leading back to the earlier form of illumination using candles.

The final chapter deals with the by-products obtained from petroleum after the kerosine has been extracted, and thus describes the early work on fuel oil, lubricating oil, and bitumens.

The book is characterized by the wide historical background to the various subjects discussed, which is a field which Professor Forbes has especially made his own.

F. H. G.

Aspects of the Organic Chemistry of Sulphur. Frederick Challenger. London: Butterworths Scientific Publications, 1959. Pp. vii + 253. 40*s*.

The present volume is described as the first of a series in which various aspects of the organic chemistry of sulphur will be considered. In this the author, well known for many years for his work in the field, has presented six essays on important topics in which the chemistry of organic sulphur is involved. Of these, three are of especial interest to the petroleum chemist, since they are concerned with the sulphur bodies which occur or can occur in petroleum, their isolation and identification, and some of their chemical reactions. While the remaining three essays deal with biological aspects of sulphur chemistry and are of less concern to those working in the petroleum field, they are none the less of considerable interest to those who have worked with sulphur bodies.

It is unfortunate from some points of view that in recent years refining methods for desulphurization have been developed which are relatively independent of the way in which the sulphur is present in the oil or other materials to be desulphurized. Hydrogenation, whether with the aid of added external hydrogen or, as in the autofining process, with hydrogen internally derived from the dehydrogenation of six-carbon ring naphthenes already present, behaves similarly with all types of combined sulphur; the latter is converted to hydrogen sulphide, and hydrocarbons are formed having the skeleton structure of the original sulphur compound. With such blunderbuss methods, interest in the precise manner in which the sulphur is present tends to become mainly academic. In former refining processes the removal of the whole sulphur-containing molecule, or its conversion to others having less objectionable properties, rendered desirable some knowledge of its structure. Even so, some interest must still remain, since the extent of sulphur removal is to some degree dependent on the nature of the compound in which it is combined. Thiophens, for example, are more difficult to desulphurize by hydrogenation than are sulphides. Furthermore, complete sulphur removal would be uneconomical, especially with higher-boiling distillates, and the remaining sulphur may be present in a form less stable to oxidation than it is to hydrogenation.

While desulphurization by hydrogenation may lessen to some extent the interest in the refinery in the actual structure of the sulphur bodies present in petroleum distillates, the same technique may prove of inestimable value to the chemist in the elucidation of the structure of these compounds in the laboratory. The use of Raney nickel has played an important part in converting sulphur bodies of unknown structure to easily identified hydrocarbons. Its use is, however, limited in that the points of attachment of the sulphur are not indicated, especially when geometrical isomers are involved.

Professor Challenger has given a very complete account of the identification of the sulphur bodies in petroleum distillates, and the methods adopted to do so. The question still remains unanswered as to whether these occur in the crude oil as such or are degradation products. There seems little doubt that they do, excepting possibly for higher polysulphides, the presence of which in some crudes is suspected.

S. F. B.

Chemical Engineering Practice. Vol. 5. Fluid Systems—1. Ed. Herbert W. Cremer and Trefor Davies. London: Butterworths Scientific Publications, 1958. Pp. 695 + xxiv. 95*s*.

The first half of the fifth volume of this series continues the treatment of fluid flow started in the fourth volume.

The chapter on pumps is largely concerned with centrifugal types. The economic aspect of pump selection is well presented, but some advice on the possibilities of modifying the characteristics of existing pumps by impellor trimming, etc., would have been useful. The section on fans and blowers is well supported by typical operating data. The treatment of compressors and pipe systems is more descriptive, although useful references are given. The chapter on the design of high pressure vessels is one of the best in the series so far, but the following one, dealing with vacuum, has a slight lack of cohesion, and some of the background material might have been omitted to leave space for other topics. There is useful information on molecular flow conditions and pumping speeds.

The second half of the book is devoted to liquid–liquid and vapour–liquid interphase mass transfer. The whole section has an air of continuity, probably due to the fact that all eight authors are either present or past members of the Birmingham school. Several texts have been published during the last ten years on the subject, and the treatment in this volume compares favourably with them.

There is a useful table giving the sources of published data available for liquid–liquid systems, and the graphical and analytical methods for extraction design calculations are dealt with in fair detail.

Vapour–liquid equilibrium is authoritatively presented in a relatively small space. The chapter on binary rectification covers the more useful of the design procedures, and again the space available is put to good use.

Multi-component distillation is dealt with less fully than in various specific papers, to which appropriate reference is

given. The inclusion of some worked examples of design calculations is a particularly good feature of this work. The chapters on equipment are largely descriptive, and only bubble cap towers are dealt with in detail. Of necessity, a considerable emphasis is placed on theoretical considerations and correlations of experimental results; however, several paragraphs outlining historical developments help to make the text interesting. L. G. M.

Analyses of Industrial Operations. Ed. Edward H. Bowman and Robert B. Fetter. Homewood, Illinois: Richard D. Irwin, Inc., 1959. Pp. viii + 485. $7.95.

This is a collection of papers which describe the actual results of some significant applications of the methods of operational research to a wide variety of industrial operations.

The 26 papers have all been previously published, most of them in journals with which the operational research practitioner is familiar, the exceptions being an IBM technical report and selections from a Massachusetts Institute of Technology master's thesis. All except a paper by Professor Bowman himself were published before 1958. It is worth remarking that although the selection is transatlantic, no papers are taken from the British publication—the *Operational Research Quarterly*.

The articles are grouped according to method of analysis—linear programming, other types of programming, queueing methods, incremental analysis, and total cost and value models. Although only one paper is concerned explicitly with the oil industry, it is clear that the generality of the approach of many of the papers will enable them to be of value to the readers of this journal in respect of ideas generated and lessons learnt in the application of quantitative methods to operating problems. To read the papers with understanding does not require a deep knowledge of mathematics, but familiarity with the techniques of operational research is desirable.

The collection of papers was made originally for graduate students at the Massachusetts Institute of Technology. For them and for any similarly qualified seminar group it must be extremely convenient to have these papers all brought into one place. The book is well designed—each paper seems well suited to the purpose of providing a sense of reality and direction for the questionings of a study group.

However, it is doubtful whether the book is of much value to those in industry who have access to collections of the relevant journals. The active researcher will probably already be familiar with most of the work described, and if he has been too busy with his own problems to keep up with those of others, then he wants only a selective bibliography to lead him back to the papers he has missed.

But what of the person in industry who sees potential in these methods but is new to the work—for the editors believe that their book will be useful to him? Maybe it is with him in mind that they have prefaced each paper with a very brief mention of the paper's special points of interest. However, this is done so tersely as to be of little help to the person working on the papers by himself. If the editors had written a short critical survey of each paper, relating one paper with another and emphasizing clearly what they like and dislike about the paper, then this book would have been much more valuable to people in industry. As it is, such readers will find the book adds little to their own system of reference to published work. D. R. K.

The Oilman's Barrel. Robert E. Hardwicke. Norman, Oklahoma: University of Oklahoma Press, 1958. Pp. xi + 122. $3.75.

The book is the result of thirteen years of research and investigation by the author into metrological questions relating not only to the gallon and the barrel but also to other measurement units (largely English).

Evidence is provided of the confusion which resulted from the use of the barrel as a unit of capacity in the earliest days of the American oil industry. This arose from the fact that, for a few years following the drilling of Drake's well in 1859, there were no railroad lines from the oilfields, so that crude oil had to be transported in a wide variety of barrel containers—in fact, any type of barrel which was reasonably sound, irrespective of its size, was used. Barrels which were designed to carry beer, wine, whisky, herrings, eels, or other products were pressed into service. The capacities of these barrels varied between 30 and 50 gallons. It was no wonder therefore that arguments arose on so-called barrel quantities. It was not until 1864–65, *i.e.* five years after Drake's well, that the first standard barrel was made in the U.S.A. This was of 42 gallons capacity, but this standard was not officially adopted by the American oil industry until 1872.

Apparently, the U.S. Government did not help to clear the confusion that existed till 1872. In 1865 it imposed a duty of $1 on every barrel of oil of not more than 45 gallons; this meant that oil filled into a barrel of 31½ gallons capacity—which was at the time in common use—would pay the same duty as a barrel containing 45 gallons of oil.

Tankcars for transport on railroads were not in common use until after 1866.

Some of the statements made in the book on gauging of oil containers and the connexion between temperature and gravity of liquid petroleum products in determining gallons or barrels at a standard temperature are debatable. It is a pity, too, that in one of his footnotes the author gives greater emphasis to a private publication—the Fisher–Tag Manual—than he does to the authoritative ASTM/IP Tables for calculating oil quantities.

The statement that " in Great Britain and a number of other countries the metric ton rather than the barrel is used for crude oil " must be challenged so far as Great Britain is concerned. Volumetric quantities for oil are given in Britain in terms of Imperial gallons; weights in long tons.

It is a little difficult to understand why in a book on a history of the U.S. oil barrel Mr Hardwicke should argue the case that Col. Drake of the U.S.A. and not James M. Williams (who produced oil in Canada in 1857) was the founder of the North American oil industry, and that in any case Pennsylvania produced oil some years before Drake became famous. The connexion between all this and the barrel is difficult to follow, particularly as Mr Hardwicke admits later that the Chinese drilled for oil and gas a thousand years ago, and bituminous materials (petroleum) were used for various purposes in ancient times.

The author concludes his book by saying, " The barrel can mean many different measures, depending on many different factors." This statement, in the view of Mr Hardwicke, presumably applies at the time of publication of the book in 1958. If, because of the universal use of the barrel as a unit of capacity in the U.S.A., the world oil industry proposes to continue the wide use of that unit for trade purposes—which may be admirable—then surely the position as at this date is fully covered. The International Standards Organization has recently announced that the ASTM/IP Petroleum Measurement Tables have been adopted as an International Recommendation. In these Tables the U.S. gallon is laid down as being equivalent to 231 cubic metres; the U.S. barrel as being 42 U.S. gallons. Conversions from barrels to other units of volume and capacity are also laid down. Tables are given for correcting volumes to standard temperature, and for conversion of volumes to weights. Surely the universal acceptance in the U.S.A. of the internationally recommended ASTM/IP

Tables will, for the future, solve the problem of the U.S. barrel, which Mr Hardwicke claims still exists.

The presentation of the excellent research work carried out by the author is marred by the extensive and lengthy footnotes throughout the text. Of the 100 pages of print (excluding the bibliography), 55 contain footnotes, apart from brief references to literature. Some of these footnotes occupy anything from one-quarter to two-thirds of a page, and some run over to the following page. Whilst these notes are exceedingly interesting to the student of the history of metrology, and indeed demonstrate the depth of the author's work, the form of their presentation tends to make concentration on the text of the book exceedingly difficult.

The publishers in their foreword say that the book has "important meaning for historians, metrologists, petroleum lawyers, and executives." It is doubtful that executives will rush to read a book in which the author says "there is even today no clear way of determining offhand just what a 'barrel' of oil is today." The door would, however, according to Mr Hardwicke, still be wide open for petroleum lawyers. H. H.

Fine Particle Measurement. Clyde Orr, Jr and J. M. Dallavalle. New York, London: Macmillan, 1959. Pp. xiv + 353. 73*s*. 6*d*.

The authors set out to survey methods of measurement of particle size, surface area, and pore volume. One's first reaction to the results of their efforts is that they have attempted to cover too much ground, so that the book tends to fall between two stools. On the one hand, there is not enough detail to make this a really comprehensive work in its own right; this is especially true of Chapters 1–5, which deal with particle size measurement. On the other hand, there is more than sufficient information presented to guide the experimenter into the right channels, whet his appetite, and direct him for more detail to other technical literature.

The wide field covered by the text has also meant that the authors have been forced to accept that the relationship of particle size, surface area, and pore volume to specific industrial problems, such as filtration and catalytic activity, is outside the scope of the book. This tends to leave the reader with a void which cannot be completely filled by reference to individual articles listed in the bibliography.

The bibliography, to which generous reference is made throughout the text, contains about 400 references. These are up to date and help to make the book a valuable conspectus of modern trends in fine particle measurement.
L. R. B.

Introduction to Chemical Engineering Thermodynamics. Second edn. J. M. Smith and H. C. van Ness. London: McGraw-Hill, 1959. Pp. 490. 68*s*.

In presenting thermodynamics to chemical engineers it is essential to treat the subject as an applied science; rigorous mathematical argument and abstruse theoretical discussion must be kept to a minimum, and yet are essential to the subject. The authors of this text-book have succeeded in achieving these objectives in a very satisfactory presentation of this difficult subject. The subject is treated in an orderly and systematic manner, and the text is remarkably free from minor errors, but it is unfortunate that the symbols used for free energies are those used by chemists and not those adopted as standard by chemical engineers.

The applications of the subject are illustrated well in numerous worked examples throughout the text, and the student can benefit by solving the many problems posed at the end of each chapter. A valuable practical feature of the book is the inclusion of folded charts of correlations and other data which are much larger than those usually presented in similar text-books, and consequently more accurate estimations of properties can be made. In addition to the presentation of methods for rigorous calculations, many empirical correlations of practical value are included. However, in a few places it was felt that the fact that some relationships were empirical, and consequently have limitations which are not always obvious, could be stressed more strongly with advantage to the undergraduate student. The estimation of thermodynamic properties by the methods of bond energies and group contributions is not mentioned, although these procedures are often very valuable to the chemical engineer.

Although the subject of phase equilibrium is treated in a chapter of 60 pages in more detail than many chemical engineering texts, the importance of this subject in distillation would justify an even more extensive treatment. It is somewhat surprising to find that although the concept of activity coefficient is used extensively in this chapter, the concept of activity is not discussed until the following chapter on chemical equilibria. The concept of the vaporization equilibrium ratio is introduced in the chapter on phase equilibria, but it is regretted that the authors have not taken the opportunity to introduce a rigorous discussion of the theoretical aspects of this concept. Such a treatment is sadly lacking in the confusing literature in this field, and would be valuable to students entering the petroleum industry.

To summarize, the book provides a valuable and readable introduction for students and can also be recommended to those whose student days are past but need a refresher in this subject. Its value would be enhanced by the inclusion of a few additional topics mentioned above, but of course authors must always compromise with length and cost, and no major pruning of the existing text could be made without sacrifice of valuable material. C. W. N.

Studies of Water Flood Performance. IV. Influence of Curtailment on Recovery. Walter Rose. Urbana, Illinois: Illinois State Geological Survey, 1958. Pp. 32.

Circular 262 of The Illinois State Geological Survey is Pt IV in the series on water flood performance. Curtailments, *i.e.* interruptions in production due to such causes as shut-in periods or proration controls, are considered in relation to their effect on water flood efficiency. It is shown that the rate of recovery is sensitive to the dominance of capillary forces and that curtailments influence recovery. Each case needs special analysis to determine maximum efficiency, and economic rates and guiding principles are suggested.

Electrokinetics. 1. Electroviscosity and the Flow of Reservoir Fluids. Norman Street. Urbana, Illinois: Illinois State Geological Survey, 1959. Pp. 18.

When liquids flow through narrow capillaries they often exhibit a viscosity other than normal, being usually higher for low-conductivity liquids, and vice-versa. This effect may influence the flow of oil and water through petroleum reservoirs. In this Circular 263 of The Illinois State Geological Survey the underlying theory is developed and some calculations made as to the magnitude of this electroviscous effect. An equation for two-phase flow through a "Yuster" model is given.

Improving Oil Recovery. Ed. George H. Fancher. Bradford, Pa.: Producers Publishing Company, 1958. Pp. 226. $3.00.

Published on behalf of the Department of Petroleum Engineering, University of Texas, the book opens with a brief article by G. H. Fancher, who is chairman of the Department, and this stresses the importance of the problem of

increasing ultimate oil recovery. This is followed by sixteen chapters, each by an authority, on various aspects of increasing recovery by water injection. History, economics, unit operation, core analysis, and injection mechanics are discussed in turn, and the significance of secondary recovery and pressure maintenance in specific areas are also dealt with. The final chapter on new techniques for oil recovery refers to such methods as the Orco process, in which carbonated water is used, high-pressure gas injection, the use of condensing gas drive, the injection of inert gases, vertical gas drive, thermal recovery, and the application of surface chemistry.

Review of Benzole Technology 1957. London: The National Benzole and Allied Products Association, 1959. Pp. 135. £1 2*s*. 6*d*. post free.

This fifth annual volume reviewing information on the subject of benzole published during a particular year follows similar lines to the previous issues and performs a valuable function. The text is grouped under twelve main headings which logically follow from production methods, through the treatment and refining of finished products, to utilization, testing, handling, and finally to brief statistical information. Each main section is further subdivided to facilitate ready reference to specific data.

As an example of coverage, the section on " Motor Fuels and Internal Combustion Engines " first treats the general aspects of engine compression ratios, fuel production, exhaust gas analyses, and so on. Combustion and engine knock are then discussed, and finally fuel additives and engine deposits are considered.

The section on " Analytical Methods " is also of particular interest, discussing as it does many methods of test which are generally applicable to the petroleum industry.

Throughout, the material has been written as a collected and running narrative, and comment is given where desirable.

Petroleum Industry in Illinois in 1957. Alfred H. Bell, Virginia Kline, and Carl W. Sherman. Urbana, Illinois: Illinois State Geological Survey, 1959. Pp. 115.

Part I of this Bulletin 85 of The Illinois State Geological Survey is concerned with oil and gas developments in the State during 1957, in which year crude oil production was 7% lower than in 1956. The decrease is mostly due to refinery strikes which caused temporary shut-downs in certain pools. Reserves at 1 Jan 1958 were 667·3 million barrels, or 34·3 million less than a year before.

Water flood operations are the subject of Part II. During 1957 a total of 382 projects were in operation and produced about 47 per cent of the total crude production.

British Instruments. Directory and Buyers' Guide 1959. London: Scientific Instrument Manufacturers' Association and United Science Press Ltd, 1959. Pp. 615. 42*s*.

This publication comprises information previously available in the two volumes " British Scientific Instruments " (published by SIMA) and " The Instrument Directory and Buyers' Guide " (published by United Science Press). Its ten sections contain a mass of useful information on many matters pertaining to the availability of instruments of British design and manufacture. There are details of the various associations allied to the industry, a list of BSI specifications, information concerning consultants, a classified index of products and their manufacturers and announcements by the manufacturers, and a very useful glossary in French, German, and Spanish.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren " Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the " Library Catalogue " published by the Institute.

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050 Guinle, R. L. A modern Spanish–English and English–Spanish technical and engineering dictionary. London, Routledge, 1938. 311 p.

080 Shell-Mex and B.P. Ltd. 1958 book of the year. London, Shell, 1959.

080 Shell Oil Company. Annual report 1958. New York, Shell 1959. 28 p.

200 United States. *Bureau of mines.* Analyses of crude oils from 470 important oilfields in the United States, by C. M. McKinney and E. L. Garton. Washington, USBM, 1957. 276 p.

220 Field, F. H., *and* Franklin, J. L. Electron impact phenomena and the properties of gaseous ions. London, Academic Books, 1957. 349 p.

260 Associated Ethyl Company Ltd. Analytical methods. London, Associated Ethyl Co., 1958.

270 American Society for Testing Materials. 1958 book of ASTM standards . . . Part 5: masonry products, ceramics, thermal insulation, acoustical materials, sandwich and building constructions, fire tests. Philadelphia, ASTM, 1958. 1113 p.

270 American Society for Testing Materials. 1958 book of ASTM standards . . . Part 7: petroleum products, lubricants, tank measurements, engine tests. Philadelphia, ASTM, 1958. 1485 p.

300 American Association of Petroleum Geologists. Habitat of oil: a symposium . . . analytically reviewed and edited by Lewis G. Weeks. Tulsa, Oklahoma, AAPG, 1958. 1384 p.

300 Royal Dutch/Shell Group. Standard legend (of the) exploration and products departments. Revised edition. The Hague, Royal Dutch/Shell, 1958.

500 Organisation for European Economic Co-operation. Gas in Europe: production, availabilities, consumption. Paris, OEEC, 1958. 146 p.

610 Association of British Chemical Manufacturers *and* Society for Analytical Chemistry. *Joint committee.* Recommended methods for the analysis of trade effluents. Cambridge, Heffer, 1958. 124 p.

610 British Petroleum Company Ltd. Safety code for tanker loading and discharging. Revised edition. London, BP, 1958. 47 p.

710 Industry Census Bureau *and* Oil and Gas Journal. A census of crude-oil refineries. Tulsa, Oklahoma, Industry Census Bureau, (195–). 31 p.

720 KNUDSEN, J. G. *and* KATZ, D. L. Fluid dynamics and heat transfer. New York, McGraw-Hill, 1958. 576 p.

730 HAMMOND, Rolt. Dispersion of materials. London, Heywood, 1958. 230 p.

730 HAPPEL, John. Chemical process economics. New York, John Wiley, 1958. 291 p.

740 GRABBE, E. M., RAMO, S., *and* WOOLDRIDGE, D. E. *editors.* Handbook of automation, computation, and control. Volume 1: control fundamentals. Los Angeles, Ramo–Wooldridge Corporation, 1958.

740 SOCIETY OF INSTRUMENT TECHNOLOGY. Automatic measurement of quality in process plants; proceedings of a conference held at Swansea 23–26 September 1957. London, Butterworth, 1958. 320 p.

750 NATIONAL BENZOLE AND ALLIED PRODUCTS ASSOCIATION. Review of benzole technology, 1957. London, NBA, 1958. 135 p.

810 ASSOCIATED ETHYL COMPANY LTD. Gasoline and gasoline engines, by C. L. Goodacre. London, Associated Ethyl, 1958. 25 p.

810 ASSOCIATED ETHYL COMPANY LTD. Tetraethyl lead as an anti-knock, by C. L. Goodacre. London, Associated Ethyl, 1958. 39 p.

810 HORLOCK, J. H. Axial flow compressors: fluid mechanics and thermodynamics. London, Butterworth, 1958. 189 p.

830 TOURRET, R. Performance of metal-cutting tools. London, Butterworth, 1958. 184 p.

990 FORBES, R. J. More studies in early petroleum history, 1860–1880. Leiden, E. J. Brill, 1959. 199 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

981. Lithologic analysis of sedimentary rocks. R. P. McNeal. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 854–79.—The role of the subsurface stratigrapher increases in importance as the number of unexplored structural traps decreases, but little detailed information regarding the descriptions and interpretations of sample cuttings has been made available in one publication.

Rocks may be described in sample cuttings as to rock type, colour, grain or crystal size, cement or matrix, impurities, porosity, stain, lustre, fossils, associated material, and subordinate features. Clastic rocks are divided into non-carbonate clastics, which include sandstone, siltstone, and clay, or shale, and carbonate clastics, which include most types of limestone and dolomite. Non-clastic carbonate rocks (reefs and bioherms) can be composed to a great extent of clastic material, but they originate from and are retained by non-clastic organisms. Evaporites compose a third major rock type.

Sedimentary rocks may have interstitial and fracture porosity, and in addition carbonate rocks may have solution porosity. E. N. T.

982. The cost of finding oil. R. E. Megill. *Oil Gas J.*, 30.3.59, **57** (14), 250.—Basic exploration data must be available in calc cost of finding oil in a given area. These include: (1) the number of employed geologists; (2) the amount of

geophysical work carried out; (3) the number of employed scouts; (4) undeveloped acreage holdings; and (5) number and average depth of dry holes. An example of determining costs from the Rocky Mountain area is given, and it is shown that, by making additional calc of development and operating costs, a comparison can be made between replacement cost per brl and the average crude price in the area. Crude prices can be affected by the price of competing crudes at refineries and other factors. 8 refs. C. A. F.

983. Ordovician Chazyan Series of Champlain Valley, New York and Vermont, and its reefs. P. Oxley and M. Kay. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 817–53.—The Ordovician Chazyan Series succeeds the Canadian Series and underlies the Blackriveran Series. In the type region of the Champlain Valley the series is separable into the Dayan, Crownian, and Valcourian stages, distinguished by faunal criteria. Thickness approaches 1000 ft as a max, diminishing by overlap, offlap, and convergence. Local variations are so great and outcrops so distributed that regional isopach maps are only suggestive. Each stage has several lithologic facies. Reefs are prevalent in sections having minimum thickness, contrasting with argillaceous calcisiltstones of the thicker sections. The reef-building organisms include some of the earliest corals and bryozoans, as well as sponges and stromatolites. The reef belt lay between lowlands of the continental interior and deeper water of W New England. E. N. T.

984. Crane trend caprices still puzzle geologists. F. J. Gardner. *Oil Gas J.*, 30.3.59, **57** (14), 249.—The Crane trend of Texas and Louisiana has proved to be a rich oil-bearing province during the past 11 years of its development. It is some 52 miles long and a max of 18 miles wide. It is not yet defined. There is no relation between structure and accumulation, which depends on porosity changes along the flanks of the trend. The productive porous zones are oolitic limestones with shell fragments, forming dendritic tongues across the Texas–Louisiana border. Pay thickness is erratic, from 2 ft up to 20 ft max. Drilling is active in the area in spite of the risks in not finding porosity development. Over 400 gas-condensate wells have been completed at depths of 5000–6000 ft on no structural evidence. C. A. F.

985. West Texas drillers go deep. C. Hoot. *Oil Gas J.*, 6.4.59, **57** (15), 185.—Deep drilling is being carried out in Pecos, Terrell, and Val Verde Counties in W Texas along the Sheffield Channel, the Pandale Anticline, and the Val Verde Basin. Activity has been encouraged by the finding of Silurian and Ellenburger gas at Brown-Bassett in Terrell County in 1957. Much exploration has been done in the Val Verde Basin, particularly along its NW flank; the area is thought to have good gas possibilities, and the deepest section is *ca* 16,000 ft. The Pandale Anticline is a faulted structure trending NW to SE, increasing in size with depth, with closure estimated at 2000–3000 ft. The Sheffield Channel is said to be a buried Pennsylvanian link between the Delaware Basin and the Val Verde Basin. Deep wells in the area are listed. C. A. F.

986. Twin finds push Paradox across Colorado line. F. J. Gardner. *Oil Gas J.*, 6.4.59, **57** (15), 183.—One field was found in the Paradox Basin of Colorado and Utah in 1958, but there have been recently two discoveries in Montezuma County: 1 Ute Mountain Tribal discovered the Towaoc field and was completed for 1236 bd from the Paradox at 5830–5885 ft, and 1 Retherford-Government, 8 miles N of Towaoc, has reported 20 brl/hr from 5820–5899 ft; pay is Pennsylvanian. C. A. F.

987. Raton Basin potential excellent in Colorado. J. R. Clair. *World Oil*, March 1959, **148** (4), 115.—Oil prospects in the Raton Basin, Colorado, are outlined. Many shallow wells have been drilled in the area, but little data are available. Potential structures exist, and reservoir rocks productive elsewhere are developed in the basin. Semi-commercial gas has been found at Garcia and helium gas at Model Dome, and there are surface oil seeps, and oil shows have been found in wells. The area of best prospects is in the NE part of the basin, where Arbuckle rocks have been known for some time; secondary porosity is probably developed along erosion surfaces as in the Central Kansas Uplift. The overlying Pennsylvanian beds also have some potential. There are possibilities of stratigraphic traps where beds thin on to folds. 6 refs. C. A. F.

988. Watch Ohio for deep drilling. G. G. Shearrow. *Oil Gas J.*, 23.3.59, **57** (13), 141.—The geology of deep formations in Ohio is outlined, and although 275 deep wells have been drilled in the state, only 23 have reached basement rocks. Limited studies indicate porosity and permeability development in beds older than Middle Ordovician, and source rocks probably occur in neighbouring areas. Two fields have been found, and several isolated wells have had production. The beds overlying the basement are Upper Cambrian sandstones, dolomitic beds, and shales, and these are overlain by Ordovician dolomites, oolites, sands, and siliceous rocks. Records are generally poor due to low quality logs, and much research is needed to locate areas for deep drilling. C. A. F.

989. The Arctic—a challenge in exploration. D. J. Belcher. *Oil Gas J.*, 16.3.59, **57** (12), 160–3.—Many novel difficulties affect geological exploration in the Arctic as a result of frost action and permafrost—the latter possibly penetrating to depths of 1200 ft or more. Outcrops are badly shattered and blocks moved distances of up to 20 ft by frost heaving; dip and strike measurements are consequently unreliable. Solifluction modifies slopes, smothers outcrops, and tends to blend one landform with another. Aerial photography is a useful tool, given specialized knowledge of the climatic effect on the terrain. Faults are often recognizable by local thawing. Geophysical exploration, especially refraction surveys, are affected by the permafrost zone, the lower boundary of which behaves as a refracting surface whose depth is unrelated to structure. Selective employment of geochemical prospecting methods is suggested, the idea being to test faults thought to "vent" deep structures for micro-seeps. J. C. M. T.

990. There's oil in Alaska. M. Birkhauser. *Oil Gas J.*, 16.3.59, **57** (12), 160–5.—Known geology and oil indications of seven sedimentary areas in Alaska are briefly discussed. The areas are: the Arctic Coastal Plain together with the Arctic Foothills, the Yukon–Koyukuk Cretaceous province, the Kandik Mesozoic and Paleozoic Basin, the Gulf of Alaska Tertiary Basin, the Bethel Basin, the Copper River Basin, and the Cook Inlet Mesozoic and Tertiary province. The best documented of these is the Arctic Foothills and adjacent Arctic Coastal Plain region, in which lies the U.S. Naval Petroleum Reserve 4, on which 45 corcholes and 36 wells have been drilled with the discovery of the Umiat 200 M brl oilfield, the Gubic 22,295 billion cu ft gas field, the Simpson 12 M brl oilfield, and the Barrow 5–7 M cu ft gas field. The Gulf of Alaska province includes the abandoned Katalla oilfield, sited on seepages, which produced 154,000 brl from 22 wells between 1903 and 1933. Exploratory drilling is in progress in this province and in the Cook Inlet province. The geology of the remaining areas is poorly known, particularly the Copper River and Bethel Basins, in which there are no outcrops of pre-Quaternary rocks. J. C. M. T.

991. Alaska's Arctic Slope. R. J. Burnside. *Oil Gas J.*, 16.3.59, **57** (12), 125–52.—The Arctic Slope region of Alaska is divisible into four physiographic and geologic provinces trending in E–W belts sub-parallel with the Brooks Range, which is itself the southernmost province. The latter and the

neighbouring Southern Foothills belt are both areas of folded, faulted, and intruded Mesozoic and older rocks. The Northern Foothills belt is one of broad and long folds, with little overthrusting or intrusions. The Arctic Coastal Plain is characterized by gently dipping to horizontal sediments, typically covered by thin Quaternary sands and gravels. Cretaceous formations constitute the largest part of the stratigraphic column, and during Nanushuk and Colville times a shoreline oscillated across the area. Inshore sands and greywackes of these formations form the known reservoirs of the Arctic slope. Other objectives are the Mississippian Lisburne limestone and a shale–sandstone–fractured chert facies of Triassic age. Of the nine known fields, Gubik, Meade, Oumalik, Square Lake, and Umiat are believed to be structurally controlled. Swelling montmorillonite clays occur in the productive zones at Umiat and Gubic. The Umiat field is unique in that most of its reservoirs lie within the permafrost zone. Crude from Umiat is green, slightly paraffinic, with a high naphthene and aromatic and low sulphur content, and is of 36·5° API gravity. J. C. M. T.

992. Statistical analysis of regional facies change in Ordovician Cobourg limestone in Northwestern New York and Southern Ontario. L. Lippitt. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 807–16.—Multiple regression analysis is applied to the study of facies change in the Ordovician lower Cobourg limestone in NW New York and S Ontario. A linear surface is fitted to the scattered outcrop data. The results indicate an increase in the lower Cobourg calcilutites NNE along the outcrop E and N of Lake Ontario and an accompanying decrease in the calcarenite texture. This is interpreted as a winnowing-out of the calcareous muds into the deeper water on the NNE.

Preferred orientation of lower Cobourg pararipples indicates that NE–SW currents predominated. Progressive change in mean pararipple wavelength tends to support the northward increase in depth of water obtained from the texture analysis.

A synthesis of the linear regression results for Shoreham, early Denmark, and lower Cobourg textural data in the NW New York area denotes max submergence in early Shoreham and minimum submergence around early Denmark. Lower Cobourg seas were slightly deeper than early Denmark.

E. N. T.

993. Discovery sparks new B.C. play. Anon. *Oil Gas J.*, 23.3.59, **57** (13), 143.—A discovery in the Beatton River–Milligan Creek region of British Columbia is expected to accelerate development in the area. The well, D 39 E (B 8–3), is reported to have found Trias D production, flowing 28 brl/hr from 25 ft of pay at 3840 ft. C. A. F.

994. Age and correlation of Huizachal group (Mesozoic), State of Tamaulipas, Mexico. R. B. Mixon *et al.* *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 757–71.—Field studies in the Huizachal anticlinorium, Sierra Madre Oriental, near Ciudad Victoria, Tamaulipas, Mexico, disclose that the Huizachal group (redbeds), formerly undivided, contains at least two mappable sequences, herein named La Joya formation and La Boca formation.

The La Boca formation consists mostly of red and green claystones, mudstones, siltstones, sandstones, and conglomerates and rests unconformably on: (1) crystalline rocks of unknown age, and (2) deformed Palæozoic strata lithically similar to those of the Marathon uplift (Texas). It is considerably folded and faulted and underlies either the La Joya formation (redbeds) or the overlying Zuloaga limestone (Late Jurassic) with angularity up to almost 90°.

The La Joya includes: (1) a lithically variable basal conglomerate; (2) a thin limestone and limestone conglomerate; (3) red mudstones, claystones, siltstones, and fine quartzose sandstones which grade upward into red, pink, or green, fine to very coarse, cross-bedded, quartzose sandstones and red, pink, or green conglomerates. The La Joya possesses conformable to low angular unconformable relations with the superjacent Zuloaga limestone; it rests with considerable angularity on the La Boca formation and on deformed sediments of late Palæozoic age. At some places it overlies crystalline rocks probably Palæozoic and Precambrian in age.

E. N. T.

995. Upper Cretaceous of Central Chiapas, Mexico. L. J. Chubb. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 725–56.—The Tuxtla or Ocozocuautla formation has been attributed to various ages from Upper Jurassic to Eocene, and there has been controversy whether it lies below or above the thick rudist limestone which, under various names, has been referred to different ranges between Comanchean and Maestrichtian inclusive. A palæontological succession covering the range Upper Turonian to Campanian has been published, but without reference to the lithological succession. In this paper it is shown that the Ocozocuautla series is above the rudist (Sierra Madre) limestone, its lithological and palæontological successions are described, and correlated with each other and with the standard succession. The Sierra Madre limestone is shown to embrace the range from Lower Cretaceous to Turonian, the Ocozocuautla series being Campanian and Maestrichtian. No evidence was found of the occurrence of Coniacian or Santonian rocks, which are thought to be absent. The discrepancies between the conclusions reached in this paper and those of earlier authors are discussed, and their reasons investigated. E. N. T.

996. West end of Serrania del Interior, Eastern Venezuela. E. Rod. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 772–89.—None of the structural elements of the Serrania del Interior of the Eastern Caribbean Mountains continues toward the W. Near the W end of the Serrania the fold axes are dragged and cut off by the right-lateral Urica strike-slip fault. Folding in the two fault blocks was independent. The relative cumulative displacement of the Urica fault is max (possibly 40 km or more) at its NW end S of Barcelona and gradually diminishes from this point SE. In the Tacat area the Urica fault turns sharply in an E direction and goes over into the Pirital thrust, where the horizontal component is finally taken up by the thrust movement. E. N. T.

997. Sahara wildcat hits. Anon. *Oil Gas J.*, 2.3.59, **57** (10), 84.—A new oil discovery has been made at El Gassi, 60 miles S of Hassi Messaoud, Algeria. Discovery well flows 2250 bd from 243 ft of sandstone–quartzite pay of Cambro-Ordovician age below 10,400 ft. BHP is 6330 psi. The accumulation is anticlinal. The same horizon is productive 500 ft deeper at Hassi Messaoud, which has now produced over 3½ million brl.

J. C. M. T.

998. The search for oil by WAPET. A review of operations and plans. Anon. *Chem. Engng. min. Rev.*, Dec 1958, **50** (12), 30–7.—WAPET (W Australian Petroleum Pty Ltd) is exploring permit areas covering the Perth Basin, the Carnarvon Basin, and the Canning and Fitzroy Basins, with a total area of 210,000 sq miles. More than £14 million has been spent on the search. Geological and gravity meter surveys of the whole area and an airborne magnetometer survey of the Canning Desert Basin have been completed. These are being followed up by seismic surveys and drilling under great difficulties. Maps are prepared and the results of field work plotted by the exploration dept at Perth. Six different types of rig have been used for structure drilling to 1500 ft and test drilling. Total drilling amounts to 200,000 ft. Oil has been found only in a 30–50-acre field at Rough Range. The training of specialist staff is being continued. Seismographic work is being continued in the Fitzroy–Canning Basins, and

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the data already collected for the whole area is being re-examined, especially for the Rough Range–Cape Range area and the Perth Basin. G. B.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

999. Continuous seismic profiler aids marine exploration. C. B. Officer. *World Oil*, April 1959, **148** (5), 107.—A continuous sound reflection device has been adapted for offshore oil exploration and has proved useful for mapping horizons down to depths of 400–1200 ft below the sea floor. It is known as the sparker, or continuous seismic profiler, and results are shown as a geological cross-section. There are two units: a sound source, using a simulated explosion in the form of a 10,000-V spark fired underwater, and a receiver recorder unit containing a signal detector. The latter consists of either a single hydrophone towed from the boat or an array for directional purposes. The system is flexible, the receiving hydrophone and spark unit being towed behind the survey ship at a distance of *ca* 200 ft, and separated by 20 ft horizontally; ship speed is 3–8 knots. With low noise level and absorption, beds of good reflection at 1000 ft below the sea floor can be detected, the water depth having little influence on the results. Examples of records are given. Surveys have been made in various marine environments around the coasts of N and S America, the W coast of Africa, and in the Persian Gulf. The tool has a useful application in marine engineering for foundation structures. C. A. F.

1000. Seismic velocity effects may hide organic reefs. Pt 1. D. C. Van Siclen. *World Oil*, April 1959, **148** (5), 118.—The geology and seismic velocity characteristics of the Pennsylvanian Stamford reef in N-Central Texas are discussed, and it is shown that it gives a false " high " on seismic maps of beds below the reef, since waves travel faster through the limestone than the enclosing shales. The limestone is *ca* 3 miles long and 1½ miles wide, reaching 1000 ft in thickness and totally enclosed in a shale section over 2500 ft thick. The reef would have been undetected seismically if the limestone velocity had been reduced to the shale rate by such factors as dolomite replacement of the limestone and a high concn of gas in the pore space. Thus, combinations of similar geological changes elsewhere could render potentially productive reefs undetectable, and, from velocity considerations, it is the more potentially producible reefs that are less likely to show up. Seismic and geological maps and a cross-section of the Stamford reef field are included. C. A. F.

1001. Unique magnetic tape playback system. H. A. Frost. *World Oil*, April 1959, **148** (5), 123.—A magnetic tape playback system for recording seismic records has recently been developed, incorporating a multi-channel " time shifter," a TV type monitor, and a " variable area " type cross-section writer. Distortions due to normal moveout and weathering can be eliminated by shifting arrival times of reflections on each trace and shifting the entire seismic trace by a fixed amount. The time shifting is carried out by a multi-trace dynamic time shifter, which consists of a magnetic coated drum with 12 fixed position recording heads and 12 variable position playback heads. Any playback head can be adjusted as the drum rotates and weathering errors can be removed. The programming of the relative movement of the playback heads is described.

" Variable area " type of presentation is preferred to " variable density " because of ease of processing; each trace is black on a white background, so that the original development of the paper is not critical. C. A. F.

1002. New exploration technique shows promising results. R. Y. Walker and S. R. Litzenberg. *World Oil*, April 1959 **148** (5), 134.—A new method of oil exploration, known as the emission technique, is based on the emission and detection of low energy γ-rays which are being continuously emitted from the subsurface. As these pass through oil-bearing rocks, there is partial absorption, and it is claimed that it is possible, from surface measurements, to distinguish anomalies which are due to hydrocarbons in the subsurface from those due to cosmic rays. The method has been tested over proven fields and has given accurate results. Details of the field work and equipment are given, a strip chart recorder electrically coupled to a sensitive scintillometer detector being used for the surface recording. The method is fast, relatively cheap, and up to 10 miles/day can be covered; but it cannot be used satisfactorily when nuclear tests are being carried out because of radioactive contamination of the atmosphere. C. A. F.

1003. Nuclear precession magnetometer successfully field tested. H. T. Brundage. *World Oil*, April 1959, **148** (5), 127.—Field tests of the nuclear precession magnetometer have shown that it is reliable and durable, and easily transported and adaptable. Normal accuracy is of the order of 3 γ, but it can be reduced to less than 1. The principle of the device is simple. A bottle of fluid containing a high content of hydrogen atoms (*e.g.* water) is surrounded by a coil through which a strong dc current is passed. Spin axes of the nuclei of the atoms become aligned parallel to the coil and the fluid will show a weak magnetic polarity after the current is cut off. The earth's magnetic field will tend to align the nuclei in the same way, but because it is weak the nuclei are caused to precess, the precession period of the nuclei being a direct measure of the earth's magnetic field. It records intermittently, which might be a disadvantage in a high-speed aircraft, but it should be possible to overcome this by instrumentation. C. A. F.

1004. Plot seismic data with electronic computers. C. A. Wood. *World Oil*, April 1959, **148** (5), 131.—Electronic computers for plotting seismic cross-sections enable data to be represented more accurately and with greater flexibility. A method is outlined for preparing point-plotted cross-sections using a digital computer and an accounting machine which has been modified to serve as a plotting device. Basic data are fed into the system on punched cards, one for each seismogram. A second card for reflections is punched for each trace on the records, and there is space for 13 reflection times. Examples of machine-computed and plotted cross-sections are included.

Programming is arranged so that depths are computed using a linearly increasing instantaneous velocity function, a linearly increasing average velocity function, or an empirical velocity curve. C. A. F.

1005. Geophysical and petrological study of Precambrian of Central Alberta, Canada. G. D. Garland and R. A. Burwash. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 790–806.—It is shown that the major part of the Bouguer gravity anomaly field over Central Alberta must be attributed to lithological changes in the Precambrian basement beneath the sedimentary section. By making use of the petrology and physical properties of samples from wells that have reached the Precambrian, in conjunction with the gravity data, a lithological map of the basement has been produced. The covered shield can be traced to the region beneath the Rocky Mountains, at least as far W as Banff. Depth estimates made from gravity profiles strongly suggest that the Precambrian has been uplifted beneath the mountains. E. N. T.

1006. Geophysical exploration—problems in Libya. F. L. Schenck. *World Petrol.*, March 1959, **30** (3), 42.—Many problems have arisen in geophysical work in Libya, where there are *ca* 80 oil concessions held by 12 companies. Terrain presents transport difficulties, particularly in areas of complex sand dunes and gullies, and water supply is very variable,

being relatively abundant in populated areas but sparse elsewhere. Smooth field operations are therefore difficult. There are automotive problems also, a reliable supply of spares being a very important factor.

Accurate maps of the country are becoming available as a result of extensive geological, geophysical, and photogeological surveys. Horizontal control is obtained by astronomic fixes of prominent points, and semi-permanent markers are usually erected at line crossings of geophysical surveys.

Gravity, magnetic, and seismic surveys have been carried out. Residual gravity and second derivative maps have proved very useful for reconnaissance. Most parts of the country are difficult record areas for seismic work, and multiple-shot patterns and multiple geophone layouts are usually required. Surface shooting techniques have been used by several companies, and correlation shooting, using carefully controlled recording techniques, has given encouraging results. Most of the anticlinal structures so far investigated have low dips, with faulting common in some areas. Widespread unconformities are thought to occur.

C. A. F.

DRILLING

1007. An engineer looks at steam drilling rigs. E. D. Arnold. *Oil Gas J.*, 6.4.59, **57** (15), 121–7.—One out of every seven rotary drilling rigs on the U.S. Gulf Coast is still steam driven, and in the heavy-class rigs one in every three. Moving expenses are much higher in the case of steam for medium depth rigs, but for deep drilling rigs moving expenses are about the same for steam and power. Fuel costs for steam are *ca* double those for power rigs. Depreciation rates, however, are an estimated $100/day less, and repairs and maintenance $50/day less for steam than power rigs. Max hook speed and load are similar with a 14 × 14-inch steam engine and a 1100-hp power drive. Steam mud pumps give excellent hydraulic programme without changing liners from surface to below 15,000 ft. J. C. M. T.

1008. Use of air cuts costs in shot hole drilling. H. L. Ray. *World Oil*, April 1959, **148** (5), 129.—Seismic shot hole drilling costs can be considerably reduced by using air instead of mud. This has been proved in the Rocky Mountain region of the U.S.A., where mud drilling costs average 34 cents/ft, with a penetration rate of 50 ft/hr. In 20–60-ft shot holes, air drilling costs an average of 24·9 cents/ft with a penetration rate of 99 ft/hr. The equipment consists of a combination type drill, with the mud pump and air compressor mounted on the drill bed, and it is possible to use air and water together where necessary. Under certain conditions air drilling is not yet practicable, *e.g.* sticky clays and shales, excessive formation water, and soft sands. C. A. F.

1009. Which lost-circulation material to use and how. B. Q. Green. *Oil Gas J.*, 2.3.59, **57** (10), 110–15.—Results of lab tests on lost circulation materials are described. Packs of glass beads of various sizes were used to simulate permeable formations, a slotted device for larger openings. Materials tested included shredded leather, mica, cane fibre, flax shive, wood chips, and cellophane; results are summarized. Size of particles needed to provide a seal increased with size of openings. Irrespective of material used, a concn of *ca* 15 lb of lost circulation material/brl mud is the optimum value, and if this does not provide a seal a coarser material, or one with a different size distribution, should be tried. A waiting period is essential before assessing results because of the time required for solids to accumulate in the bridge. J. C. M. T.

1010. Ship-side drilling is successful. Anon. *Oil Gas J.*, 30.3.59, **57** (14), 102–3.—The first fully-floating drilling ship to operate in the Gulf of Mexico is drilling below 5000 ft with no difficulties. The well is in the Louisiana West Delta area, projected depth 10,000 ft, in 26 ft of water. Drilling is carried out over the side of the vessel, and the rig itself is fairly conventional except that the travelling block runs in a track to prevent swinging. Heaviest weather encountered produced 7-ft waves and a 5° roll, but this did not interrupt drilling. J. C. M. T.

1011. Use high calcium drilling fluid to stop shale hydration. P. H. Monaghan and J. L. Gidley. *Oil Gas J.*, 13.4.59, **57** (16), 100–3.—Hydration of clay minerals in shales during drilling (leading to hole enlargement, excessive mud visc, and formation plugging) can be reduced by using muds in which calcium ions are present in amounts of *ca* 3500 ppm. Lab and field tests of such a mud are described. Calcium chloride was used to provide the calcium ions. Difficulties associated with high calcium muds are high filtration rate and suppression of the electric log SP curve. Filtration rate is minimized by adding the calcium chloride to the bentonite suspension (instead of adding bentonite to the calcium chloride soln), by using an agent such as ferrochrome lignosulphonate, carboxymethyl cellulose, or polymerized gums derived from sugar, and keeping the pH near 8. A mud of this type was tested in four S Louisiana wells at depths of 11,500–14,500 ft, and produced less borehole enlargement and suffered less visc build-up than caustic–quebracho mud. The high-calcium mud also produced larger shale cuttings and tolerated contamination from cement and salt water, while drilling rate was higher. Electric logs were satisfactory. J. C. M. T.

1012. Continuous velocity logger yields excellent results. H. W. Hardy. *World Oil*, April 1959, **148** (5), 111.—The continuous velocity log can be used to give velocity data for seismic interpretation, and has proved very useful in subsurface geology for correlation and for indicating porosity. The most recently developed sonic logging tool uses a sound source with two detectors, so that no correction is required for mud travel time and the log is a plot of interval travel time (Δt). Different sound sources have been used and, in the system described, a timer excites a magnetostrictive transducer with an electrical charge which is changed into a sound pulse. For each pulse (10 per sec), Δt is timed, amplified, and recorded by a galvanometer at surface. At normal logging speeds a record is made for about every 2½ inches of borehole traversed. The Δt log has many advantages over the resistivity and radioactivity logs because bed definition is improved and there is no lag in recording. Qualitative estimation of porosity can be made by comparing the Δt log with a resistivity log; if, for example, a zone of high resistivity has indications of low velocity it can be assumed that this is due for formation fluids. Attempts are also being made to use the log for quantitative estimates of porosity. Examples of continuous velocity logs are included. C. A. F.

PRODUCTION

1013. How Pan American repairs casing with glass-fabric-coated plastic liner. E. R. Jennings and R. P. Vincent. *Oil Gas J.*, 6.4.59, **57** (15), 136–46.—To repair leaky casing a plastic-impregnated glass fabric liner is formed *in situ* using a repair tool incorporating an expandable mandrel. Cleaning is previously done using a steel brush assembly and solvent for 1 hr. Temp is measured to determine the most suitable plastic to use. Setting time is 12–24 hr. The patch can stand differential pressures of 2000–5000 psi and reduces internal dia of casing by only 0·3 inches. Cost is estimated as 50% less than squeeze cementing. J. C. M. T.

1014. Miscible drives: a growing tool for oil recovery. Anon. *Oil Gas J.*, 23.3.59, **57** (13), 64–9.—The status of miscible oil secondary recovery methods in the U.S.A. is reviewed. 39 projects are planned or operating and *ca* six have been abandoned; brief facts concerning all these are given. The LPG slug method is the most popular and is used in 24 of the projects. Six are using enriched gas drive, three high pressure gas injection, four are solvent floods using LPG, one is experimenting with alternate slugs of LPG and water, and one combines LPG slug and enriched gas drive with water injection. It is thought that use of water in miscible drives may improve sweep efficiency. J. C. M. T.

1015. Gas chromatography in the oilfield. H. Gilmour and R. W. Snell. *Petroleum, Lond.*, 1959, **22** (2), 65.—A knowledge of the gas constituents in oilfield natural fluids is essential in good reservoir engineering practice, and a simple method of analysing gas samples from field separators enables adequate, on-the-spot control to be applied. Chromatographic techniques are superseding the complex and laborious fractional Podbielniak distillations used in the past. A simple and cheap apparatus which is ideal for field and lab use is described in the paper. M. F. M.

1016. New water flood method successful. J. Enright. *Oil Gas J.*, 20.4.59, **57** (17), 60–1.—A recently patented method of water flooding has been successfully tried in the Adena J sand pool, Morgan County, Colorado. The method involves injecting water at the gas–oil contact in a tilted reservoir at the rate at which oil is produced, thus maintaining original pressure. When oil production falls substantially only produced water is injected and pressure allowed to drop, permitting gas cap to expand, pushing oil and water ahead of it. After all recoverable oil is produced the gas may be produced. Past fears that water injected at the gas–oil contact might channel quickly down through the oil zone have proved unfounded. J. C. M. T.

1017. Micro-organisms are bad actors in water flooding. A. Lada. *Oil Gas J.*, 13.4.59, **57** (16), 93–5.—Bacteria, algæ, and moulds are causes of plugging and corrosion in injection wells. The most objectionable micro-organisms are the sulphate-reducing bacteria and the iron bacteria. Under anærobic conditions sulphate-reducing bacteria promote galvanic corrosion of iron by utilizing hydrogen at cathodic areas. Continuous wastage of metal of injection wells results, added to which the formation becomes plugged with ferrous sulphide. Iron bacteria produce copious deposits of yellow or reddish slime which can clog pipelines and formations, but they require a supply of oxygen, and to that extent are easier to control. Lab methods of estimating sulphate reducers in natural waters, and also the efficiencies of bactericides, are being developed by the API. Substances used to control micro-organisms include quaternary ammonium cpds, imidazolines, phenolics, fatty amines, organic mercurials, chlorine, copper sulphate, and hypochlorite. Formaldehyde and antibiotics have also been tried. Toxicity has to be considered in making a choice. J. C. M. T.

1018. Viscous crudes respond to water flooding. Anon. *Oil Gas J.*, 30.3.59, **57** (14), 189–93.—Theoretical analysis of the water flood problem has suggested that a favourable mobility ratio is required for successful results. However, viscous crude is being recovered satisfactorily by water flood in a number of fields in Kansas and Oklahoma, despite the unfavourable mobility ratio. Case histories of six such Kansas fields are given. J. C. M. T.

1019. How to calculate temperature profiles in a water injection well. J. T. Moss and P. D. White. *Oil Gas J.*, 9.3.59, **57** (11), 174–8.—The rate at which an injection well will take water or other fluids is a function of their visc, and hence varies with temp. This is governed by the heat gained from or lost to the formation, and this depends on the rate of injection as well as on the geothermal gradient and the surface temp of injected fluid. A method of calculating the temp of the fluid entering the formation is outlined employing a series of successive approximations. Necessary constants are tabulated. J. C. M. T.

OILFIELD DEVELOPMENT

1020. Oilfield development. C. A. Fothergill. *Petroleum, Lond.*, 1959, **22** (1), 5; **22** (3), 107–10.—A series of articles on oilfield development which will be dealing with the principles and methods of winning the oil from the ground. These articles would be more useful for the reader with an overall interest in the oil industry than for the oilfield specialist.

Apart from economic or political considerations, there are two basic quantities which need to be determined as early as possible in the life of an oilfield. These are: (1) the extent of the subsurface accumulation of oil and gas, and (2) the probable amount of oil or gas which can be recovered from the accumulation. These two factors are considered in the first article.

The second article deals with "Some Geological Aspects." Methods of determining basic geological data are outlined, together with techniques for correlating this data and the pattern of development drilling to assess the field's potential. Electric logging of oil wells is also discussed, and a useful illustration is included which shows the structure of an oilfield. M. F. M.

1021. How to appraise wildcat prospects. G. C. Hardin. *World Oil*, March 1959, **148** (4), 119; April 1959, **148** (5), 138.—In the U.S.A. the average discovery rate for new field wildcats has ranged from 10·7 to 12·2% over the past 13 years, so it can be assumed that on average one wildcat in nine will be productive. Of these only one in five will find a field with a reserve of 1 million brl or more, so that only one in 25 wildcats will find a profitable field. This ratio could be improved by correlating geological and economic aspects of all prospects and drilling only where there is promise of sufficient production to offset inevitable dry holes. A minimum monetary return from a successful new field wildcat should be set at 50 to one, since the ultimate net return expected from production from the available acreage should be not less than 50 times the total cost of the prospect. In the U.S.A. exploration overhead costs for the company initiating the search will vary from *ca* $25,000 to *ca* $50,000 per prospect, although $100,000 could be incurred. Factors to be considered in estimating costs of development are outlined.

In Pt 2, geological evaluation of prospects in wildcatting, in relation to costs, are briefly outlined. Four examples from Texas and Louisiana are given. The decision to drill is based on a profit-to-risk ratio. The chances of locating a 10–50 million brl field will be increased if part of the money available for wildcat drilling is not used on prospects where profit-to-risk ratio is less than 50 to one. C. A. F.

1022. World exploration expands in 1959. Anon. *World Petrol.*, March 1959, **30** (3), 48.—World exploration activities during 1958, excluding the U.S.A., Canada, and Communist countries, are briefly reviewed by areas and countries, the main features being the expansion in activity in Argentina and N Africa. In Algeria there are *ca* 38 rigs operating, and *ca* 90 wells are expected to be drilled in 1959 by CREPS. There have been recent discoveries in Libya also. Other developments of interest include offshore discoveries in the Persian Gulf and several new finds in the Paris basin. C. A. F.

1023. Alaska: a glittering new frontier. F. J. Gardner. *Oil Gas J.*, 16.3.59, **57** (12), 193.—Although oil was found in Alaska in 1903, intensive drilling has taken place only during the last few years, largely due to the release of data by the U.S. Navy and the decline in U.S. domestic discovery rates. The geology of the country is little known, but there are at least nine major basins, and these contain good prospects for oil and gas accumulations. A ready market could develop for Alaskan oil along the W coast of the U.S.A. and in Japan. Disadvantages of development include severe climatic conditions and difficult terrain giving transport problems. Further increased activity in Alaska is expected. C. A. F.

1024. Accessibility is the key to present Alaska drilling. W. T. Smith. *Oil Gas J.*, 16.3.59, **57** (12), 194.—The more accessible parts of Alaska are currently being actively explored. These include the S part of the state from Bristol Bay on the W to the Yakutat region on the Gulf of Alaska in the W. This zone includes the Cook Inlet, the Kenai Peninsula, and the Katalla–Yakataga area. Drilling is proceeding in several areas along this belt, and extensive geological and geophysical surveys have been carried out. Operations in each area are briefly noted.

The only known areas of Alaska which can be considered to be without oil prospects are the Aleutians and the "Panhandle" of S Alaska, where volcanic and mineralized rocks are found. C. A. F.

1025. The Nisku Reservoir, Joffre area, Alberta. N. C. Tunna. *Canad. Min. metall. Bull.*, 1958, **51**, 759–61.—This oilfield lies N and E of Red Deer City, Central Alberta. It has an area of *ca* 27,000 acres with a primary recoverable reserve of 26,000,000 brl of stock tank oil. It is being developed on a 160-acre pattern with an average drilling depth of 7050 ft. There are 65 completed wells and 10 rigs drilling. The reservoir is a stratigraphic trap formed by a porosity pinch-out against the down-dip flank of a Leduc reef. The geology of the formation is described. The yield is of a sweet paraffin-based crude with a gravity of 41° API, pour pt 20° F, a sulphur content of 0·2%, and a visc of 42 SUS at 70° F. G. B.

1026. Drilling and production to increase in Brazil. Anon. *World Oil*, March 1959, **148** (4), 126.—Crude oil production in Brazil in 1959 is expected to reach 25 million brl, compared to *ca* 19 million brl in 1958. Plans are to drill *ca* 150 development wells and 117 wildcats and stratigraphic tests during the year and activity will be at a higher level than in 1958. A new find has been reported from near Sao Sebastiao in the Bahia area, and initial production is said to be 300 bd. C. A. F.

1027. Offshore work proceeds in South China Sea. Anon. *World Oil*, March 1959, **148** (4), 124.—Offshore operations in Borneo are outlined. In recent years offshore geophysical surveys, including gravity and seismic reflection methods, have been carried out covering some 30,000 sq miles. The work has centred about the Seria field, which extends offshore, and detailed work has been carried out to define its seaward extension. Offshore drilling is now being undertaken from mobile drilling platforms. Production from the field averages 110,000 bd, and it is the largest field in the British Commonwealth. C. A. F.

TRANSPORT AND STORAGE

1028. Reclaiming tank bottoms by solvent treating. G. Kinney. *Oil Gas J.*, 20.4.59, **57** (17), 127.—Some 30 pipelines and refinery tanks varying from 5000 to 30,000 brl capacity have been successfully treated by the process, which involves agitating the bottom contents, thus exposing them to action of a chemical which suspends them in oil again, the suspension being absorbed by fresh oil. The suspension is then pumped out and the wax recovered. 11 case histories are given. G. A. C.

1029. Recent types of pressure storage tanks at Donges refinery. R. Chambaud. *Bull. Ass. franç. Tech. Pétrole*, 1959, 159–73.—Initial pressure storage was in tanks increasing from 3500 to 15,000 m³, following which 20,000-m³ vessels (ten erected) were standardized. Design particulars and photographs. Operating pressure, + 125 g/cm², − 5 g/cm², metal requirement 430 tons. V. B.

1030. World tanker statistics 1958. Anon. *Inst. Petrol. Rev.*, 1959, **13**, 126–7.—Of the world total of 1936 vessels of 9,269,983 gross tons launched in the world in 1958, 429 were oil tankers, totalling 4,775,279 gross tons. This represents 52% of the tonnage output for all classes of vessel, compared with 45% in 1957. Details of the registration of oil tankers launched in 1958 are tabulated, and Liberia is again the leading country of tanker registrations in terms of tonnage, with Norway second and Britain third. A. D. S.

1031. Effect of entrained liquids on gas measurement. R. A. Schuster. *Pipe Line Ind.*, Feb 1959, **10** (2), 24–9.—The AGA tables used in the measurement of natural gas by orifice meters are calculated for dry gas. Full-scale tests with dry and wet gases show that the error introduced by liq entrainment is independent of the sp gr of the liq and directly proportional to the vol % of liq. At a gas pressure of 900 psi, 1 brl liq/million cu ft of gas causes an error of +0·1655%. The error is less at lower gas pressures. The tests were run at gas pressures from atm to 900 psi with water, salt water, and dist as the contaminating liq and with orifice meters of different sizes. The results presented can be used to correct meter readings if the amount of entrained liq is known. G. B.

1032. Considerations involved in handling kerosine. M. G. Zabetakis and B. H. Rosen. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 296–306.—The history of fires and explosions attributable to kerosine during various transportation operations is sufficiently well known to warrant a study of the flammability characteristics of this material. Kerosine forms explosive vapour–air mixtures when the liq is in contact with air at temp above its fl pt. It can also form explosive vapour–mist–air mixtures and explosive foams in air at temp well below its fl pt. These hazardous conditions can be eliminated most effectively by the addition of a sufficient quantity of inert gas to prevent flame propagation through the resultant mixtures.

The quantities of carbon dioxide, flue gas, and nitrogen required for the prevention of flame propagation through kerosine vapour–air–inert gas mixtures and of carbon dioxide required for the prevention of flame propagation through kerosine foam were determined. In addition, tests were conducted aboard a type T-2 tanker during a kerosine-loading operation to determine the effectiveness of a carbon dioxide blanket in reducing the oxygen concn above the liq to a safe value. Large-scale lab tests are planned to determine the effectiveness of inert gases in preventing gas explosions during kerosine-loading operations. (Authors' abstract.)

1033. Transporting liquefied methane. C. I. Kelly. *Inst. Petrol. Rev.*, 1959, **13**, 106–12.—Use of natural gas in town gas supplies has intensified interest in its transportation in the cold liq state ("liquefied methane"). The historical de-

velopment of suitable containers is reviewed, and it is concluded that the success of liquefied methane transportation is attendant on the following factors: correct choice of metals which do not develop brittleness at very low temp, use of efficient insulants to minimize evaporation loss, provision to cater for change in tank size on warming and cooling, use of good fabrication and operational techniques, provision of space for a ballasting cargo, and conformity of the whole scheme to the requirements of official bodies. Details are given of the successful transportation from the U.S.A. to the U.K. of liquefied methane in the *Methane Pioneer*, and the consequences of this experiment on the future of world-wide transportation of this product are discussed. Cost of natural gas at source and delivery and its future availability are considered. A. D. S.

1034. Internal coating of gas pipelines. R. H. Crowe. *Oil Gas J.*, 6.4.59, **57** (15), 107.—Preliminary results from 87 flow tests on Transcontinental Gas Pipeline system on both bare and internally coated 30-inch and 36-inch pipeline show an increase in flow efficiency for the coated pipe. Study showed that lowest efficiency was on sections of line laid with pipe that had been stored longest in weather before installation, hence internal surface was pitted.

Most efficient internal coating was one of the epoxy-resin type, the pipe being pickled in an acid bath, rinsed with fresh water, and hot air dried before coating applied.

Mechanical power brush cleaning was adopted for cleaning in pipe roller from plate.

It was also found that half usual pressure was required for running pigs through coated pipes. Charts show pipeline flow efficiency data on 30-inch and 36-inch pipe by use of ammonia injection method. G. A. C.

1035. Digital data handling techniques of telemetering in integrated systems. L. K. Hedding. *Pipe Line News*, April 1959, **31** (4), 39–42.—It is now possible, using the digital data handling techniques, to plan a fully automatic pipeline operation, accounting, book-keeping, customer billing, and future planning. Some of the features of such an integrated design system are: (1) max security and max reliability; (2) lowest possible operational costs; (3) multi-station co-ordination where there are several field locations to be controlled; (4) max utilization of the system's components where dual or multiple functional usage can be realized; (5) acquisition and storage of data in digital form.

A very brief description of a digital indicator is given in the paper. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1036. Air cooling saves for Sohio. Anon. *Oil Gas J.*, 6.4.59, **57** (15), 131.—Even where fresh water is in plentiful supply, it is shown that air cooling at the Sohio's Toledo refinery is more economical. Capital cost of system is lowest when air is used to cool to 140° F, and a trim cooler is used to cool from 140° F down to required outlet temp. Tables show summary of capital costs and exchange cost comparisons. G. A. C.

1037. Radioisotopes in instrumentation. J. W. Otvos. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 328–37.—A large number of instruments have been developed in the past 10 years in which a radioactive isotope is used as a radiation source. Liq level measuring devices, density and thickness gauges, radiographic equipment, and instruments that perform elemental chemical analyses are some important examples in the petroleum industry. A unified discussion is given of the generalized instrument, which consists of a source, a sample, and a detector. The fundamentals of the interaction with matter of β-particles, γ-rays, and neutrons are defined, and the applications of these interactions to instrument design are illustrated. The published data on the absorption coeff of the chemical elements for radiations of various energies are summarized. It is shown how this information can be used to choose an appropriate isotope, to fix the instrument dimensions, and to predict which elements are susceptible to analysis. Specific instruments for the analysis of hydrogen, sulphur, and lead in hydrocarbons are discussed in some detail. A detailed reference list of articles on the use of isotopes in instrumentation is presented. (Author's abstract.)

DISTILLATION

1038. Computer distillation programme handles wide component range. R. N. Maddox and J. H. Erbar. *Oil Gas J.*, 27.4.59, **57** (18), 116.—Oklahoma State University have developed a plate-to-plate computer programme designed for IBM 650, but which can be adapted for nearly any medium-sized computer. It has successfully handled all feed systems so far attempted, and the programme is available to all.

The programme has proved capable of dealing with systems with methane through absorption oil and others containing components ranging from hydrogen through 360° F normal bp oil. G. A. C.

ABSORPTION AND ADSORPTION

1039. Stripper-stabilizer problems yield to digital computers. C. R. McNeese. *Oil Gas J.*, 27.4.59, **57** (18), 106.—Atlantic Refining Co has developed a computer programme to give rapid accurate solutions to multicomponent fractionation problems, specifically applied on cold-feed stabilizers. Can also be used for strippers which involve rectification and rich-oil de-ethanizers which involve absorption and stripping. The programme is based on the Edmister stripping-factor method. A " theta " method used similarly to the " Lyster ", Sullivan *et al* procedure, is used for rapid convergence.

Simple problems are cited. G. A. C.

CRACKING

1040. Power recovery gas turbines for fluid-bed cat crackers. J. C. Dygert. *Oil Gas J.*, 20.4.59, **57** (17), 94.—A 4000-hr test at Shell Oil of Canada's East Montreal refinery showed feasibility of using a gas turbine, after a special separator had removed enough of the cat particles from the flue gas to prevent serious erosion of the turbine blading, to recover energy from the regenerator flue gas. The turbine can drive an air compressor delivering combustion air on to the regenerator dense bed. Power circuits illustrate the article. G. A. C.

1041. Rapid determination of fluorine, sulphur, chlorine, and bromine in catalysts with an induction furnace. A. L. Conrad, J. K. Evans, and V. F. Gaylor. *Analyt. Chem.*, 1959, **31**, 422–5.—For the determination of F, the weighed sample is mixed with SiO_2 and metallic Fe and heated in the furnace. The F is volatilized as fluorosilicic acid, absorbed in aq NaOH, and titrated spectrophotometrically with $Th(NO_3)_4$. Cl and S are determined in one sample by heating with Fe, V_2O_5, and alundum (SiO_2) and passing the evolved gases through 0·005N $AgNO_3$ and 1·5% aq HCl + KI successively. The S is continuously titrated with KIO_3. The Cl is determined by

amperometric titration of the excess of $AgNO_3$. For the simultaneous determination of Br and S the combustion is carried out as for Cl, except that the absorbent is CCl_4 cooled in ice. The CCl_4 soln is shaken with H_2O, H_2SO_4, and KI and titrated with $Na_2S_2O_3$. These procedures are also applicable to the analysis of engine deposits. G. B.

ISOMERIZATION

1042. Isomerization adds to your octane picture. H. R. Grane, J. K. Ozawa, and G. R. Worrell. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 348–53.—The conversion of *n*-pentane and *n*-hexane to their isomers gives a very substantial octane increase. The Pentafining process effects this isomerization with little yield loss. The selectivity of the cat is demonstrated with once-through yields for C_5's and C_6's. The economics of pentafining are clarified by showing applications to several typical refinery situations. To achieve a higher gasoline pool octane, isomerization is compared to increased severity for cat reforming. Although isomerization is considerably more costly over a range of pool octane levels, a point is reached where the economics change very rapidly, and isomerization facilities should be installed. *iso*Pentane is one of the few components that can be blended into superpremium fuels. The road octane blending value, as well as the Research ON rating, is well above 100.

(Authors' abstract.)

CHEMICAL AND PHYSICAL REFINING

1043. Molex process upgrades gasoline. D. B. Broughton and P. B. Carson. *Oil Gas J.*, 6.4.59, **57** (15), 119.—The process separates continuously all of the normal paraffins as a group from other types of hydrocarbons by use of absorbent "molecular sieves." The absorbent is used in a fixed-bed isothermal manner, feed and separated product streams being uniform and continuous.

Thus the aromatic content of gasoline is lowered while maintaining high research ON.

The process can be used in conjunction with cat reforming in several ways, and tables show economics. G. A. C.

1044. Selective finishing process has reached commercial stage. W. F. Franz *et al.* *Oil Gas J.*, 6.4.59, **57** (15), 116.—Texaco selective finishing process can up-grade diversified stocks such as cat reformate, light straight-run naphtha, heavy FCC naphtha, or heavy straight-run naphtha as long as they contain low ON straight-chain components.

The process employs a selective absorbent, synthetic ziolite material, the unit cell of which is in the form of a modified cube.

Charge stock is passed over a bed of selective absorbent until the void spaces, formed by removal of water of hydration in the crystal structure, are filled with straight-chain molecules until saturation has occurred. At this stage the second part of the cycle desorption is achieved by sweeping the bed with a light hydrocarbon vapour or fixed gases; the cycle is repeated when all the absorbed straight-chain material has been removed.

Flow diagrams are given and tables show response of various stocks to the process. G. A. C.

1045. How to use molecular sieves for natural-gas treating. E. L. Clark. *Oil Gas J.*, 27.4.59, **57** (18), 120.—Mol sieves give twice the dehydration capacity of conventional dessicants, with longer life. A single-stage rapid cycle drying and sweetening unit for natural gas has been developed. The feed to the plant at full line pressure is passed through dehydrator for drying. 10% of total gas flow is bled off, passed through heater to raise temp to 400° F, and then through bed for regeneration. The effluent hot gas is cooled and passed through water accumulator and then reblended with main flow, to give average water content of 5·1–6·1 lb/MMscf. G. A. C.

SPECIAL PROCESSES

1046. Isomate for top octanes. H. G. Krane and E. W. Kane. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 342–7.—Isomerization of light naphtha appears to have a clear place in processing plans to meet the continuing push to higher octane gasoline. Upgrading light naphtha through isomerization will become a necessary addition to cat reforming of heavy stocks when max ON of gasoline are required. More immediately, isomerization is of interest in raising ON, even before the full potential of cat reforming is exhausted. The Isomate process offers refiners an attractive isomerization route. A highly active cat permits the use of operating conditions which give products of 96–98 Research ON with the addition of 3 ml TEL/gal, without the need for recycle. With the recycle operation, a product of up to 106 Research ON can be produced with little yield loss. Along with high-octane, regenerative reforming, Isomate provides a means for producing top-octane blending stocks over the full boiling range of gasolines.

(Authors' abstract.)

1047. High-octane blending components from pentanes. H. Shalit *et al.* *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 372–9.—Cat dehydrogenation of virgin C_5 fractions is a method of increasing the ON of such fractions. This paper reports the results of a preliminary process study of pentane dehydrogenation over a Houdry chromia–alumina cat. Several pentane mixtures were studied in order to determine the interrelation of yield octane, and charge composition. Substantial octane improvements were obtained, with good yields, *e.g.* the ON of *iso*pentane was increased from 92·3 to 99 Research ON, clear, with a C_5 + yield of 97%. The higher the charge *iso*pentane content, the higher the ON at any particular yield and, conversely, the larger the yield at any ON. Thermal dehydrogenation produced much poorer liq yields than did cat dehydrogenation. Pentane isomerization gave somewhat better yields of product, up to the octane level of pure *iso*pentane; however, cat dehydrogenation is more flexible in that a greater range of pentane charge compositions can be used up to *iso*pentane itself, and a higher octane ceiling is obtainable. Among the various combinations of dehydrogenation and isomerization considered, a most interesting one is isomerization to equilibrium, followed by dehydrogenation of the equilibrium mixture. (Author's abstract.)

1048. The Iso-Kel process. E. F. Schwarzenbek. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 354–62.—Iso-Kel is an isomerization process developed by The M. W. Kellogg Co for the upgrading of pentanes and hexanes present in light naphtha and natural gasoline or produced from other processing operations, such as reforming and cracking. The process employs a precious metal cat (non-platinum) which has been specifically prepared to give long cat life without regeneration and to give high isomerization activity with negligible cracking side reactions. The cat is operated under hydrogen pressure. The high cat activity results in an operating temp considerably below that normally employed in conventional heavy naphtha reforming operations. The high selectivity of the cat is demonstrated by an ultimate gas production of only 0·9% for the conversion of *n*-pentane to a 99% by vol yield of *iso*pentane. In the processing of pentanes and hexanes a single reactor is employed. The accessory fractionation equipment required depends on the composition of the feedstock and the quality of the product desired. Recycle isomerization of the *n*-pentane and once-through isomerization of the hexane

fraction is usually recommended. Iso-Kel processing of typical commercial feeds produces an *iso*pentane fraction with an ON of 105 with 3 ml TEL/gal and an *iso*hexane rich fraction with an ON of 89–94 with 3 ml TEL, depending on feed composition. The overall processing of typical feedstocks results in a 98–99% yield and ON of 95–100 with 3 ml TEL.

The investment costs of a 3000-bd unit will vary between $400 and $500/brl, depending on the amount of fractionating equipment employed. Payouts will vary from 1·4 to 1·8 years before taxes, and direct operating costs will vary between 16 and 22 cents/brl, including cat costs.

(Author's abstract.)

1049. The use of a hollow mixer in the classical refining of insulating oils. (In Serbo-Croat.) V. Tisler. *Kemija u Industriji*, 1959, **8**, 67–9.—The purification of insulating oils is divided into the physical and chemical purification. Three samples of insulating oils have been chemically purified. The oil was treated in a mechanical mixer, a hollow mixer, and by blowing in air under pressure. The oxidn stability of the raffinate has been investigated by three methods: the Baader, Kissling, and IEC methods. It has been established experimentally that the hollow mixer saved 40% on chemicals and wash water in the refining. (Author's abstract.)

METERING AND CONTROL

1050. The adaptation of a chromatograph, stream analyser, to the Snyder gasoline plant operation. B. Denny. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 19–20.—A gas chromatograph was installed so that residue gas from two deethanizers could be sampled. A later modification permitted the sampling of four streams. Each stream is analysed every 15 min. As a result, the recovery of propane has been greatly improved. The analyses also showed the need for ratio controllers for the oil–gas ratio. G. B.

1051. Use of chromatography as a laboratory control instrument for refinery operations. L. N. Locke. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 14–15.—The experience of one company in developing suitable columns for analysing the naphtha feed and raffinate, saturated and unsaturated light hydrocarbons for refinery control, residue gases, and gasoline are summarized. G. B.

1052. Chromatography as a guide to fractionator operation. A. B. Altom. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 13–14.—Gas chromatography affords a quick and easy method of control analysis of the feed and products and of samples taken at various points in the fractionator. A quick method of checking the total impurities is to run the chromatogram until all the main components have passed and then to reverse the carrier gas flow and the detector connexions. All remaining components then show as one peak. G. B.

1053. A progress report on data logging. 1. The case history of three data-logging systems. E. E. Ebner, Jr. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 317–19.—The Standard Oil Co (Ohio) has installed three data logging systems in the past year and a half. Two of these have performed below expectation.

This paper presents the case history of each of these three installations. Justification, operational problems, and results obtained for each system are included. The author concludes that if the advantages of data processing are to be fully realized, manufacturers must design more reliable equipment. Of equal importance, refiners must realize that to service these loggers the most highly skilled refinery instrument personnel are required. These technicians must be specially trained and assigned on a continuous basis to provide the daily attention necessary to keep the equipment operating.

2. Data logging, scanning, and information systems get all-out test at new Tidewater Delaware refinery. J. McDonald. *Ibid.*, 319–22.—The decision to install data logging and scanning at Tidewater's new refinery in Delaware was developed as a result of an intensive survey of information systems. Pneumatic instrumentation was favoured because of the availability of standardized components. Data logging, by itself, was not considered as important as scanning and probably would not have been adopted if continuous scanning had not been available. The use of an automatic scanner in the operation of a hypothetical large-scale refining unit is discussed. It was decided to install a scanner in each single unit, in as much as a master scanner for the whole refinery was considered impractical because of human limitation in scope of comprehension. The designed system features printing of integrated averaged daily figures to give management, at all levels, a condensed picture of the operation. Provision was made to allow operators to scan the board visually in the event of the failure of the scanner and/or logger. Debugging appears to be successful and max utilization of the information systems is anticipated when the operator training programme is completed.

3. A user's appraisal of automatic data logging. E. C. MacMullan. *Ibid.*, 322–7.—The Bayway refinery of Esso Standard Oil Co has had an automatic data logger in service on a process unit for two years. The installation, which is experimental, has been a testing ground for evaluating service factor, accuracy, and economic justification. This work has shown that it is possible to install equipment of this type in a refinery control room. The logger can be satisfactorily maintained by a refinery instrument mechanic with periodic help from the manufacturer's serviceman. The accuracy of the data produced is high enough to permit its use for process accounting. Justification of logging equipment remains a problem, however. It does not appear probable that the operating manpower on most refinery process units can be reduced by installation of a data logger. Accounting savings can be realized by the use of automatically logged data, but the magnitude of the savings is not sufficient to justify the entire logger. Some reductions in control room instrumentation can be made if the logger has provisions for single-point print out. However, this saving is also too small to justify the entire logger. There are places in a refinery where a data logger could be justified by a combination of these advantages, but at this time these places constitute a minority. The addition of control functions to a logger which could improve operation of the unit would expand the number of possible installations. (Authors' abstracts.)

PRODUCTS

ANALYSIS AND TESTING

1054. Gas chromatographic determination of fuel dilution in lubricating oils. R. A. Porter and J. F. Johnson. *Analyt. Chem.*, 1959, **31**, 866–9.—The sample inlet system to a gas chromatographic column consists of passages in a block heated to 315° C. The volatile components flashed off from the sample and internal standard are carried by the He carrier through a short column which traps any entrained oil and into the chromatographic column. The internal standard is *n*-dodecane or 2-methylnaphthalene added as a soln in oil which has been heated under vac. The results are higher than those obtained by the ASTM dist procedure. Samples may be as small as 0·25 ml. G. B.

1055. Gas chromatographic determination of dissolved oxygen in lubricating oil. P. G. Elsey. *Analyt. Chem.*, 1959, **31**, 869–70.—A gas chromatographic column is fitted with a sample inlet system consisting of a U-tube fitted with two sintered glass disks and an inlet port midway between them. This tube is removable and can be by-passed. It is maintained at 75° C by means of heating tape. Only the dissolved gases reach the analysing column, which is packed with Linde mol sieve type 5A, so that the analysis is completed in 10 minutes and the column is not contaminated with high boiling fractions. The carrier gas is He flowing at 50 ml/min. The limit of detection is 0·01 vol % of O_2, and the standard deviation of one determination is 2·2% of the mean. The only known interference is from argon, which has the same retention time as oxygen. G. B.

1056. Practical pointers on gas chromatography. A. J. Miller. *Oil Gas J.*, 20.4.59, **57** (17), 105.—A panel discussion is reported from Oklahoma City regional meeting of Natural Gasoline Association of America, whose purpose was to give the plant man answers to questions on practical use of the method in gas processing units. Fundamentals are explained and practical applications shown, such as automatic monitoring of individual components such as nitrogen, CO_2, oxygen, and almost any hydrocarbon found in most plant streams.

From among questions answered it is shown that it takes 25 minutes to analyse one gas sample, very little maintenance is required, and calibration is carried out once a week.

G. A. C.

1057. Exhaust gas analysis by gas chromatography combined with infra-red detection. W. B. Heaton and J. T. Wentworth. *Analyt. Chem.*, 1959, **31**, 349–57.—An instrument is described for the identification and determination of individual hydrocarbons in exhaust gases in concn down to 1 ppm. The sample, with oxygen as carrier gas, is freed from H_2O, CO_2, and CO and passed into a chromatographic column. The hydrocarbons leaving the column are burnt to CO_2 over a cat and passed into an ir detector. The composition of the exhaust gases of a car engine has been determined under four different running conditions and with different fuels. The composition is strongly dependent on the type of fuel used.

G. B.

1058. Analysis of natural gas samples by vapour phase chromatography. A. P. Hobbs. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 33–6.—The gas is passed through two columns in series with an active carbon trap between them. The first is a chromatographic column which separates the C_1 to C_6 paraffins but does not separate air from methane. The active charcoal removes all hydrocarbons, and the second column, which is packed with mol sieve type 5A, separates N, O, and methane. The two columns have separate detectors and recorders. The peak areas obtained do not agree with the vol composition of the samples. Empirical factors are found to depend on the composition. Net Btu values calc from vapour phase chromatography and from dist analysis are, however, in good agreement, and vapour phase chromatography can therefore replace analytical dist for routine control samples. G. B.

1059. Chromatographic and infra-red continuous gas analysers. P. U. Zoller. *Bull. Ass. franç. Tech. Pétrole*, 1959, 113–28.—Two techniques are contrasted; description (illustrated) of Perkin Elmer 184 (chromatographic) and Bichromateur 93 (ir) equipment; sketches of applicability to natural gas, alkylation, and petroleum chemical processes.

V. B.

1060. Determination of sulphur traces in naphthas by lamp combustion and spectrophotometry. R. W. Kupp and J. E. Barney. *Analyt. Chem.*, 1959, **31**, 596–7.—A modification of the ASTM lamp method for the determination of S is more precise at low concn than the standard method. It is applicable to concn of 1–400 ppm of S. The naphtha is burnt in accordance with the ASTM method and the products absorbed in H_2O_2. The soln is buffered with Na acetate and acetic acid. Ethanol and Ba chloranilate are added, and the extinction is measured at 330 mμ for the 0–40 ppm range or 530 mμ for the 40–400 ppm range. G. B.

1061. Review of applied analysis. Petroleum. R. L. LeTourneau. *Analyt. Chem.*, 1959, **31**, 730–49.—This review covers: general (17 references), gas chromatography (108 references), process instrumentation (28 references), crude oil (26 references), gases (37 references), lubricants (48 references), wax, asphalt, and grease (45 references), hydrocarbon and hydrocarbon type analysis (111 references), sulphur (55 references), oxygen (53 references), other elements (68 references), pollution (88 references), and miscellaneous (41 references). G. B.

1062. Hydrocarbon compound-type analysis of automobile exhaust gases by mass spectrometry. D. M. Coulson. *Analyt. Chem.*, 1959, **31**, 906–10.—Mono-olefins cannot be distinguished from *cyclo*paraffins by their mass spectra. Separation can be achieved by passing an aliquot of the sample through a column of $Hg(ClO_4)_2$ and $HClO_4$ supported on firebrick. With a carrier gas flow of 110 ml/min at 100° C olefins are quantitatively absorbed. The mass spectra of treated and untreated aliquots are compared. The interpretation of the mass spectra is discussed. G. B.

1063. Solid petroleum hydrocarbons and their effect on wax properties. R. T. Edwards. *Petroleum, Lond.*, 1959, **22** (2), 45–9.—Mass spectroscopic analysis of paraffin wax indicates that it consists almost entirely of saturated cpds. The quantity of aromatic rings is very small. The first step in improving wax quality involves the removal of undesirable components, such as oil and colour bodies.

The crystal structure of high-boiling hydrocarbons present in the wax, as established by X-ray diffraction patterns, is discussed in the paper, and the effects of non-normal hydrocarbons on the mol arrangement and crystallinity of petroleum waxes are outlined. This work, it is stated, is just the beginning of a programme of research to be carried out in future.

M. F. M.

1064. Determination of ethylenic double bonds by quantitative hydrogenation. S. S. Tiong and H. I. Waterman. *Chim. et Industr.*, 1959, **81**, 204–15, 357–69.—Halogen addition

methods, and previous hydrogenation procedures, for measuring unsaturation are discussed. Method derived by present authors is based on Pd cat (on activated charcoal) using acetic acid as solvent. Apparatus (diagram) and procedure described in detail, H_2 absorption measured volumetrically. Numerous test results are tabulated and compared with calc and also (for fatty products) with Wijs values. Special study is made of method's applicability to aromatic cpds; if these contain one or two non-condensed rings error thereby introduced is not serious and ethylenic double bonds can be estimated, for condensed polyaromatic cpds H_2 absorption by ring structure is, however, significant. V. B.

GAS

1065. Fuel cells. E. Gorin and H. L. Recht. *Mech. Engng, N.Y.*, March 1959, **81** (3), 63–5.—This paper is mainly concerned with the development of fuel cells for direct generation of electric power from fossil fuels such as coal, but also considers the use of natural gas as fuel. The high temp fuel cell which operates in the range 500°–850° C at atmospheric pressure can employ fuel gas either generated directly from coal or from natural sources and uses air as oxidant. Type of fuel cell used and its potential as a primary energy source are discussed. The overall heat material balance has been made around a fuel cell operating at 0·75 V, and efficiencies for fuels, produced by hydrodevolatization of coal, by complete coal hydrogenation, and from natural gas are compared. Efficiency of 65% can be attained using natural gas, compared with 70% for complete coal conversion, and a comparison of fuel costs compared with those involved in generation of nuclear power is made. It is concluded that the fuel cell should permit coal to remain competitive with nuclear power on the basis of fuel cost over a much longer period than would be the case for a conventional steam plant. A. D. S.

1066. The future use of natural gas liquids in manufacturing premium motor fuels. R. E. Sutherland and D. H. Belden. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 113–18.—By a combination of the Penex process and Platforming, a high quality motor fuel can be produced directly from natural gas liq. An economic assessment is presented which is based on a survey of the supply and demand balance for light hydrocarbons. G. B.

1067. Future use of natural gas hydrocarbons in petrochemicals. A. P. Hobbs. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 109–12.—The author forecasts continued increase in the demand for natural gas products, mainly as the basis of elastomers and plastomers. Increasing use of land for housing and increasing demand for food is reducing the supply of competitive materials from vegetable sources. New processes are creating new products and new demands. G. B.

1068. Minimizing plant operating costs. R. F. Naul. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 85–7.—The author presents a list of details which need attention to prevent waste. Broadly, fuel economy and reduction of record keeping are important classes. General criteria to be applied to each detail are that the expenditure must be necessary either for maintaining production, for plant preservation or for safety, or it must show a profit in itself. It must represent the cheapest material or method that will do the job satisfactorily. G. B.

1069. Removal of carbon dioxide from natural gas by hot potassium carbonate. B. O. Buck and A. R. S. Leitch. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 71–7.—The hot K_2CO_3 process is best suited to pressures above 250 psi with CO_2 concn of 5–50% and extraction required to 0·5%. The plant is similar to an amine plant except that no liq heat exchangers are needed. Under appropriate conditions the cost of treatment is less than the cost of amine treatment, and less corrosion is encountered. Actual plant data are tabulated. G. B.

1070. Treating high CO_2 content natural gas. R. B. McLaughlin. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 69–71.—Gas containing 30% of CO_2 by vol is being treated on a large scale by the Girdler process using a 20% soln of monoethanolamine in the Mitchel CO_2 removal plant of the Permian Basin Pipeline Co. Very severe corrosion troubles are being studied. A brief description of the plant is given. G. B.

ENGINE FUELS

1071. Cat cracker gasoline made by the Sisak petroleum refinery. (In Serbo-Croat.) A. Mosic and E. Knezevic. *Kemija u Industriji*, 1959, **8**, 74–7.—A fast-growing demand for diesel fuels, balanced by an increase of refining capacity and a less steep growth of gasoline consumption, resulted in a stoppage of imports. Yugoslavia began to export gasoline to Central European markets. With its up-to-date facilities, including a fluid cat cracker, only the petroleum refinery at Sisak is able to match the steadily growing qualitative requirements of the European consumers. In the stabilized cat cracker gasoline the aromatic hydrocarbons are prevailing in the boiling range above 125° C. A cautious widening of the entire boiling range above 200° C is not harmful to the octane rating by the motor method. Inspection of cracker process data and gasoline characteristics reveals an increase of aromatic and unsaturated hydrocarbons with an increase of the recycle ratio. Raising the temp has a similar effect. Saturated cyclic cpds are found among hydrocarbons in the boiling range from 75° to 175° C. There are no paraffins in the cuts above 175° C. On the other side, there is a plenitude of pentanes, hexanes, and heptanes. Olefinic hydrocarbons are almost equally spread through the whole boiling range from pentenes to dodecenes. (Authors' abstract.)

1072. Nitroparaffins as engine fuel. E. S. Starkman. *Petroleum, Lond.*, 1959, **22** (1), 19.—The paper relates the research work now being carried out on a family of nitroparaffin fuels by Professor Starkman of the University of California. An important consideration in the application of nitroparaffins to engines is their mode of combustion and decomposition. This is dealt with in some detail in the paper. The availability of oxygen in nitroparaffin fuels and its recombination with carbon and hydrogen correspondingly increases the thermal energy which can be carried into the combustion process per unit of charge to the engine. Nitroparaffins, and particularly nitromethane, being thermally sensitive, exhibit a tendency to induce pre-ignition in an engine. However, the experimental data shows a marked performance improvement for spark ignition engines. This performance improvement may be equally or more applicable to diesel engines, particularly where oxygen deficiency or smoke properties of the fuel are problems. The pre-ignition tendencies of nitroparaffins and the oxygen contained in the fuel are advantages in the diesel engine. M. F. M.

1073. Road octane numbers of tomorrow's gasolines in tomorrow's cars. J. J. Greytak, J. S. Bellah, and W. E. Morris. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 244–80.—Planning the production of gasolines for tomorrow's high C.R. cars requires information on the road octane quality which can be expected from possible future gasoline compositions. To provide such information, more than 5000 road ON were obtained in four 11 : 1 and 12 : 1 C.R. cars for 73 blends made from 28 components. Research and Motor octane values were also measured.

Cat reformates generally had higher road ON than cat cracked components of the same Research ON. 2,3-Dimethylbutane, light alkylate, and *iso*pentane had the highest road octane blending values of the components tested. Light cat cracked naphthas, polymer trimer, and mixed pentane–hexane isomerization products did not raise the road ratings of base fuels having road octane ratings above 100. Many of the blends had road ratings of 102 to over 105.

An average of Research and Motor octane values was found to be most useful for predicting Modified Uniontown road ratings and low-speed Modified Borderline ratings, with little improvement as a result of including such factors as hydrocarbon type analysis or dist properties. High-speed Modified Borderline ratings were best for those fuels having high Motor ON and high aromatic content.

The determination of surface-ignition tendencies showed that the high ON fuels were similar to current superpremium gasolines. (Authors' abstract.)

1074. A refinery view of fuels for the future. S. P. Blumberg. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 281–91.—Rapidly increasing engine C.R. in new cars have been accompanied by a corresponding rise in octane quality of motor fuels. Extrapolations of current trends indicate that high-performance cars of 1960 will require a premium motor fuel of approx 110 Research ON. The results of a study are reported, covering the feasibility of meeting the predicted vol and quality requirements of future motor fuels by a stepwise addition of currently available commercial octane improvement processes to an existing 50,000-bd refinery. Processes included in the study are cat reforming, desulphurization, alkylation, superfractionation coupled with isomerization, and extraction of cat reformates. The inclusion of all these processes resulted in an upgrading of the Research octane quality of the total gasoline pool from 98·0 to 102·5, and the Research octane quality of the premium grade from 98 to 110·8. This required an added refinery investment of $18 million, an increase in total investment of 40%. The manufacturing costs of the premium grade were increased by 6·1 cents/gal, which represents an overall octane improvement cost of 19·9 cents/Research ON brl. The effects of aviation gasoline sales and the marketing of three grades of motor gasoline are discussed also.
(Author's abstract.)

1075. Matching gasoline anti-knock performance and future engines. T. W. Warren *et al. Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 221–43.—Definition of the combustion characteristics of future motor gasolines in tomorrow's engines has been the objective of an extensive programme in the Ethyl Corpn Research Laboratories. Anti-knock behaviour, which is considered to be the most important combustion characteristic, was thoroughly investigated by means of controlled tests of high-compression engines on the road. The various combustion phenomena resulting from combustion-chamber deposits were also studied as part of the overall programme, because of their effects on gasoline designs.

The relationships between gasoline characteristics and knock-limited performance were investigated in three high-compression engines. These engines were selected because of their high volumetric efficiencies and because each of the highly developed combustion-chamber designs represented a different school of thought regarding optimum design. Each engine was modified so that it had a nominal 11 : 1 C.R.

Prior to gasoline evaluation, a complete calibration of each engine was conducted on engine dynamometers to assure that carburation and ignition characteristics were realistically tailored for the best utilization of commercial-type gasolines. This phase of the programme has provided extensive information on the compromises between engine performance and gasoline requirements that are available to the engine designer in order to achieve the optimum compromise.

Following dynamometer calibration, each engine was installed in an automobile for the purpose of rating fuels under accelerating conditions on the road. More than 100 commercial-type gasolines, including a wide variety of hydrocarbon-type compositions, were rated in the three vehicles. The extensive data secured with this large number of fuels permit a sound analysis of the important factors that determine road anti-knock performance. Various correlations between the Research ON, sensitivity, and hydrocarbon composition of gasolines and their road anti-knock performance were determined. It was found that Research and Motor ON do a good job of defining gasoline performance on the road at low engine speeds. At high speeds, however, consideration of gasoline composition, in addition to Research and Motor ON, is useful in predicting gasoline anti-knock performance.

Based on this study, refiners will find it desirable to maximize the paraffinic and aromatic content of fuels to attain satisfactory operation at high engine speeds. Olefinic blending components, which give the lowest cost per Research ON, will continue to be effective in meeting the minimum Research ON specification required to satisfy the engine at low speeds.

A parallel programme has been carried out to study the phenomena caused by combustion-chamber deposits with gasolines of different compositions at the 100-octane level. Three gasolines of varying aromatic and olefin content were extensively tested in three makes of cars having C.R. of 10 : 1. It was determined that changes in the hydrocarbon composition of gasolines can affect the stabilized knock requirements of vehicles, and that the effects vary with car make. As the aromatic content of the fuel was increased, surface ignition and rumble also increased in the car makes which experienced these types of erratic combustion.
(Author's abstract.)

1076. The new manganese anti-knock and natural gasoline. R. J. Riggs, W. W. Sabin, and C. J. Wolf. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 51–60.—A new anti-knock, methyl*cyclo*pentadienyl Mn tricarbonyl, is being developed by the Ethyl Corpn under the designation AK-33X. It is intended to supplement TEL, than which it is more expensive. It gives the greatest response in paraffinic blends, and is thus particularly suitable for addition to natural gasolines. Response data are given for AK-33X and TEL in a number of blends, and economic considerations are discussed. G. B.

1077. The key to balanced motor fuel quality. T. W. Legatski, O. C. Bridgeman, and E. W. Aldrich. *Proc. 37th ann. Conv., nat. Gas. Ass. Amer.*, 1958, 45–51.—Fuels must be balanced to give easy starting, quick warming up, and good acceleration without having undue vapour locking tendency. This can be achieved by blending with isomerized natural gas liq. Trends in fuel volatility, characterized by ASTM dist and RVP, have been assessed from a survey of the fuels sold in different localities at different seasons. Charts are presented for the evaluation of fuels for their suitability under different ambient conditions. G. B.

GAS OIL AND FUEL OIL

1078. Miscibility and storage stability of fuel oils. D. F. Rosborough. *Schweiz. Arch. angew. Wiss.*, 1959, **25**, 102–6.—Swiss standard calls for four grades, of max visc 9, 12 cS/20° C, 37, 130 cS/50° C. Causes of immiscibility and storage instability outlined and accelerated filter plugging test (dist fuels) and NBTL heater test (residual fuels) described (diagram of apparatus); curves illustrating correlation of results of former test with burner condition given. Difficulty of defining flow properties of fuels and inadequacy of pour point test is explained. V. B.

LUBRICANTS

1079. Analyses of equilibrium operating temperatures of railroad journal bearings. W. M. Keller and G. L. Pegman. *Lubric. Engng*, 1958, **14** (3), 108–15.—A graphical method of analysis for determining equilibrium operating temp of railroad journal bearings under varied operating conditions is described, using existing lab data on friction characteristics of the bearing, friction properties of the waste pack lubricator, and heat dissipation characteristics of the bearing assembly. Applications of the method are discussed, together with factors leading to significant decrease in bearing operation temp. Increased oil visc was found to increase equilibrium operating temp and to reduce extent of unstable operating region. J. G. H.

1080. Lubrication of the RAE high-speed wind tunnel. Anon. *Sci. Lubric.*, July 1958, **10** (7), 13–21.—The new high-speed wind tunnel recently installed at RAE, Bedford, is described and illustrated. Constructional details and lubrication provision for the compressor are set out and lubrication of the main drive gear box and motor generator set is outlined, with details of means used to prevent ingress of oil into the tunnel. J. G. H.

1081. Recent research on hydraulic seals. D. F. Denny. *Sci. Lubric.*, Sept 1958, **10** (9), 12–17.—Research on the behaviour of fluid sealing devices at the British Hydromechanics Research Association at Harlow is described and illustrated. Studies of friction, lubrication, and wear phenomena as applied to seal materials, the testing of different types and designs of seals, and the detailed consideration of the performance of one particular seal, the three main angles of approach, are briefly discussed, together with the measurement of rubber friction, suction of rubber, leakage of rubber seals, the special properties of O rings for rotating shafts, and the special requirements for eccentric shafts. J. G. H.

1082. Lubrication in the nuclear age. C. G. Williams. *Sci. Lubric.*, Nov 1958, **10** (11), 13–16.—The increasing provision of nuclear power stations results in a corresponding increase in the demands made on the lubricants used, both from the standpoint of conventional lubrication practice and from the angle of radiation-resistant lubricants in such situations as lubrication of control rod mechanism and charging mechanism in natural uranium graphite moderated CO_2 cooled reactors. The effect of radiation on hydrocarbon oils and greases is discussed, and means of imparting radiation resistance are indicated, together with possible applications of silicone fluids and di(-2-ethyl hexyl) sebacate. J. G. H.

1083. Lubrication of aircraft oscillating control bearings at high temperatures. D. C. McGahey and R. S. Barnett. *NLGI Spokesm.*, Dec 1957, **22** (9), 14–27.—Details are presented of a test rig developed at Texaco Research Centre for the investigation of lubrication problems encountered in control bearings operating at temp up to 550° F in high-speed high-altitude aircraft. Procedures, test operations, and results using five types of seals are reported in detail and indicate the necessity for seals of special heat-resistant materials, *e.g.* teflon, and fibreglass, or metal. With such seals certain solid thickened silicone fluid greases gave best performance at high temp encountered. J. G. H.

1084. Coking tendencies of lubricating oils. Anon. *Petroleum, Lond.*, 1959, **22** (1), 13–17.—Deposit formation in engines caused by coking of the lubricant on hot surfaces has been a problem since the development of the first IC engines. These deposits can lead to knocking difficulties in automotive spark ignition engines, bearing failures in turbo-prop or turbojet engines, and valve failures in free piston engines. Because of the importance of these problems, much of the lubricant development work in recent years has been aimed at reducing the coking tendencies.

The paper covers a large number of different types of lub oils. The effect of base oil type or panel coking tests and also the effect of visc of oil on coke weight have been investigated, and results are shown in tabulated form. The influence of different types of commercial additives on coking tendency has also been shown. Vi improvers increased coking tendency, though much less than the increase due to detergent additives. M. F. M.

1085. Vacuum dehydration of oils. G. J. Topol. *Lubric. Engng*, Jan 1958, **14** (1), 19.—Detrimental effects of water in lub oil are indicated, and the importance of its removal is emphasized. Vacuum dehydration methods previously employed for this purpose have proved expensive and complicated, and details are presented of a new dehydration procedure which largely overcomes these disadvantages. Equipment and methods used are described and test results presented. J. G. H.

1086. Performance of zinc dithiophosphates as lubricating oil additives. R. Larson. *Sci. Lubric.*, Aug 1958, **10** (8), 12–19.—Recent developments in design of IC engines have placed an increased load on lubricants used with a corresponding demand for effective additives, of which zinc dithiophosphate has proved notable in its multipurpose functions. Its effects as anti-oxidant, bearing corrosion inhibitor, and anti-wear agent are discussed in detail, with special emphasis on the mechanism and reactions involved. 8 refs. J. G. H.

1087. The mechanical evaluation of lubricating oils. Anon. *Petrol. Times*, 8.5.59, **63**, 359.—A combination test rig which can be used for the AVI (diesel engine) test only, the WI (petrol engine) test, or both has been produced by Heenan & Froude Ltd, Worcester, for Lubrizol. The equipment includes a special Froude IE 2 hydraulic brake capable of absorbing and measuring up to 7 bhp at 1500 rev/min mounted on a bedplate to take either an AVI or a WI Petter lab engine. The equipment is standardized in very detail. G. A. C.

1088. Extensive field tests on popular cars show value of Supplement 1 oils when running under sludge-forming conditions. Anon. *Sci. Lubric.*, July 1958, **10** (7), 21–4.—Details are presented of a large-scale programme of road testing motor oils undertaken by Lubrizol at Derby to demonstrate the superiority of additive-treated oils in the running of popular car engines. Straight oils and additive-treated oils up to Supplement 1 level of the SAE 20 and SAE 10W/30 grades were tested over 25,000-mile runs in Hillman Minx, Morris Minor, Vauxhall Velox, and Triumph TR 2 cars. Results obtained indicated that additive-treated oils resulted in reduced engine wear and minimum sludge formation under the cold starting and running conditions encountered, these being such as would be normally met with in popular small cars in their normal operation. J. G. H.

1089. Corrosion- and wear-reducing effect of zinc dithiophosphates in modern motor oils. R. Larson. *Schweiz. Arch. angew. Wiss.*, 1959, **25**, 54–61; *Erdöl u Kohle*, 1958, **11**, 791–4.—ZnDTP, used in U.S.A. as lub additive to extent of 14,000 tons p.a., has three-fold function, oil anti-oxidant, bearing anti-corrosion, and wear-reduction, last mainly on cams and cam followers. Mechanism of each function of ZnDTP is discussed, with test details and tabulation of results, with special reference to influence of alkyl group in the ZnDTP on the particular property; *sec*-alkyl grouping (*e.g. sec*-butyl) is amongst the most overall effective. V. B.

1090. Influence of low temperatures on the lubricating capacity of mineral oils. R. M. Matveevsky. *Wear*, 1958–9, **2**, 315–17.—Tests on a four-ball machine modified to permit

heating or cooling of the oil are reported. There is an upper temp limit for each non-additive mineral oil at which the friction increases suddenly. With decreasing temp below this limit the friction decreases steadily. A drawing of the apparatus is given. G. B.

1091. Enamel glasses as lubricants for forming sheet metal. A. Hegarty. *Sci. Lubric.*, Feb 1958, **10** (2), 12.—New structural alloys for the aircraft industry having high strength-to-weight ratios at above 500° F, and the availability of new titanium alloys have presented new problems in forming processes. Conventional lubricants have proved ineffective, and the possibilities of low melting glasses for this purpose are being investigated. Details are presented of a lab lubrication evaluator intended to test the properties of materials as potential lubricants for drawing and forming operations. Results obtained indicate that molten glasses would function as effective lubricants up to 1200° F and would also function as oxidn inhibitors in the forming of titanium. Adequate correlation between lab and service tests has yet to be obtained. J. G. H.

1092. Deterioration of gear lubricants in service. C. R. Noll. *NLGI Spokesm.*, Aug 1957, **22** (8), 26–8.—Charts illustrating the deterioration of gear lubricants taken after 5000 and 10,000 miles of service in trucks employed in the 1956 ordnance gear lubricant field tests conducted at Yuma, Arizona, are presented. J. G. H.

1093. Development and application of a broad performance range gear lubricant additive. R. K. Williams, W. C. Brandow, and J. W. Schulte. *NLGI Spokesm.*, Jan 1958, **22** (10), 8–14.—Severe conditions encountered in rear axle lubrication have rendered necessary the development of additives enabling gear lubricants to be compounded to effectively operate under such conditions. Details are presented of investigations conducted by Lubrizol in the development of appropriate additive. Operating requirements, lab test procedures, and road test operating conditions drawn up are set out and the correlation of these requirements with the proposed modified MIL-L-2105 specification are discussed leading up to the origin of the API GL-4 designation. Field test data with GL-4 oils are reported and illustrated; properties and handling considerations are briefly discussed. 6 refs. J. G. H.

1094. General Motors looks at rear axle lubricants. N. A. Hunstad. *NLGI Spokesm.*, 1958, **22** (2), 12–20.—General Motors hypoid rear axle lubricant recommendations over the period 1937–57 are tabulated and briefly discussed. The advantages claimed for draining or not draining are considered and the emphasis laid by General Motors on anti-score properties is explained, and their latest requirements in this respect are stated. Experience with the new GL-4 lubricants is reported and the desirability of more operating experience with these before they are adopted in place of the presently used multi-purpose gear lubricants is stressed. J. G. H.

1095. Material transfer in monomolecular layers of a boundary lubricant. G. L. Gaines, Jr. *Nature, Lond.*, 1959, **183**, 1110.—Results of some preliminary measurements of area of true contact and transfer of stearic acid and potassium 42 between mica surfaces are reported. Results obtained are preliminary and crude, but they do show that some transfer of both stearic acid and potassium ion occur. This investigation is of interest in connexion with processes occurring in boundary lubricant layers, since ability of molecules to move from monolayers on one member of a sliding couple to the other member is important in protection of surfaces. A. D. S.

1096. New thickener for multipurpose lubricating greases. R. J. Rosscup, D. R. Oberlink, and W. L. Hayne. *Lubric. Engng*, Jan 1958, **14** (1), 16.—Present conditions in industrial, military, and automotive fields call for new thickeners for lub greases. Requirements for potential thickeners are set out and details are presented of a new thickener developed by reacting an isocyanate with an amine in a mineral oil designated DAC. Lab tests and field test results in a wide variety of applications are recorded in some detail. J. G. H.

1097. Determination of grease consistency using an automatic worker viscometer. H. J. Connors. *Lubric. Engng*, Jan 1958, **14** (1), 22.—Details are presented of a new automatic worker viscometer developed at Westinghouse Research Laboratories for evaluation of the consistency of lub greases. Fundamental theory of lubricant flow is discussed in relation to results obtained, and need for more work on thixotropic nature of grease is emphasized. J. G. H.

1098. Grease cartridge. C. E. Gere. *NLGI Spokesm.*, 1957, **22** (5), 24–32.—Development of the grease cartridge as a dispensing medium is described, its advantages outlined, and requirements in design and manufacture are set out. J. G. H.

1099. Grease bleeding, its mechanisms and measurement. E. G. Ellis. *Sci. Lubric.*, Sept 1958, **10** (9), 20–5.—It is noted that the problem of grease bleeding is one which has developed only during the past 30 years. Early test methods are discussed, together with recent theories as to the causes of bleeding. Current tests are considered under the classification of heat stability and pressure tests, and are presented in tabulated form with data on test conditions. Recent work on the effect of bleeding on grease performance is summarized, and the need for closer correlation between test data and field experience is emphasized. J. G. H.

1100. Test for lubricating grease performance under water-wet conditions. W. H. Peterson, J. B. Accinelli, and T. Skei. *NLGI Spokesm.*, Nov 1957, **22** (8), 18–25.—The ill-effects of moisture in anti-friction bearings are noted, and the importance of using only greases with good overall water-wet properties is emphasized, these properties comprising corrosion resistance, lubricating qualities, and water resistance. Details are presented of a test rig incorporating a bench type drill press developed by Shell which provides in a single piece of equipment an adequate estimate of total water-wet performance. Methods of operation, inspection, and rating are discussed in detail, and results so obtained correlate well with field tests. Differences between static and dynamic corrosion are discussed, together with the effect of operating variables on dynamic corrosion. J. G. H.

1101. Shear stability of a bentone grease. H. F. Sutter. *NLGI Spokesm.*, Jan 1958, **22** (10), 18–21.—Results are reported of a study of the effect of shear level on the mechanical stability of a bentone grease following the noting of variations in stability associated with differences in shear levels applied to the grease. It was found that low-level shear stability was obtained by producing an initially heavier grease and reducing this to the desired consistency by treatment in a kettle-mill for a period of an hour. Oxidn inhibitors proved to have little effect on the stability of kettle-milled greases. J. G. H.

1102. Experience of steel mills with the bleeding of lubricating greases. J. S. Aarons. *NLGI Spokesm.*, March 1958, **22** (12), 12–15.—The importance of resistance to oil separation by bleeding in the effective functioning of lub greases is emphasized, and the bleeding and evaporation tests incorporated in the AN-G-3A specification are described in some detail and their limitations as tests under operating conditions are indicated. A static heat test developed in the lab at United States Steel which evaluates greases by exposure to a temp of

350° F for a period up to 300 hr is described in some detail, and the prime importance of temp as a predisposing factor to bleeding is emphasized. J. G. H.

BITUMEN, ASPHALT, AND TAR

1103. The rheological properties of bitumens and tars. E. N. Thrower. *J. Inst. Petrol.*, 1959, **45**, 80–93.—This discussion is prefaced by a brief description of the materials used, and of the conditions to which they are subjected. The stress applied to road surfacings and the composition of bitumens and tars are briefly considered. The rheological behaviour of these materials at high and at low temp is then discussed. Finally, an account is given of the "brittle" properties of tars and bitumens at low temp. A. D. S.

1104. Delaware's conference with Neoprene modified asphalt. S. S. Scarborough. *Rds & Str.*, 1959, **102**, 180.—Use of Neoprene synthetic rubber helps in maintenance of roads in areas of heavy traffic. Contractors' usual equipment can handle the modified asphalt in essentially usual manner, the dry-weight Neoprene content being 1½%, cut back with naphtha to make the RC3. Application is at 200°–210° F and at 0·25 gal/sq yd, at a pressure of 260 psig. Test sections show improved adhesion of chips to the Neoprene modified asphalt, good skid resistance, and increased road use. G. A. C.

SPECIAL HYDROCARBON PRODUCTS

1105. Wax is end product, not by-product. L. H. Betow *et al.* *Oil Gas J.*, 13.4.59, **57** (16), 124.—Continental Oil Co at their Ponca City, Oklahoma, refinery use an existing wax-pressing plant and wax sweaters for de-oiling, and have added to the facilities with a large new wax sweater of modern design to produce a premium-grade dairy wax. This wax is produced from a waxy dist side-cut from the dist tower of a 40,000 bd crude topping unit operating on Kansas and N Texas crudes. Waxy oil is chilled to 40° F before passing through multi-leaved presses, and molten slack wax is sweated in a series of shallow pans vertically stacked. The wax, after conventional clay treatment, is steam stripped for improvement of odour and supplied either as liq in bulk or slabbed in a Greer continuous moulding unit. The finished wax has high coverage ability, is tough and flexible, and cartons coated with it withstand rough handling in packaging machinery. A flow sheet is given. G. A. C.

1106. Correlation between dielectric loss and chemical stability of mineral oils. T. Salomon. *Electrochem. Soc., Symposium on Liquid Dielectrics, Philadelphia, May, 1959. Preprint (I.F.P., April 1959, ref. 3240, 35 pp).*—Elect tests (dc resistivity; p.f. at industrial supply frequency, 20 kV/cm; apparatus described and illustrated) carried out on oils during aging (Weiss-Salomon test, air, Cu cat, 115° C (some tests at 100° C), duration variable). 13 oils (no details) tested, results plotted and discussed in considerable detail. Initially most oils show improvement in elect tests (no explanation suggested). Further course of elect deterioration can take various forms; steady increase, increase beginning at end of induction period of oxidn, oscillatory increase, and decrease with numerous maxima at about the same level. Although there is correlation between p.f. increase and chemical stability, evidence is that sludge and acidity are not primarily responsible for elect losses and there is no quant relationship between former and latter; some of these may be due to low temp (*ca* 70° C) decomp of sulphuric esters resulting from acid refining, this view supported by decrease in S content (*e.g.* 0·064–0·005%) with aging, noted in certain cases. Distinction is drawn between impurities present in new oil and those formed during aging, *e.g.* by interaction with metals that may be present. Elect losses mainly due to "impurities," *i.e.* oil-soluble cpds (other than acids) of unknown constitution and which do not necessarily catalyse oil oxidn; different types of such impurities may exert a synergistic effect. V. B.

1107. Recovery and up-grading of aromatic hydrocarbons. M. R. Perrus. *Bull. Ass. franç. Tech. Pétrole*, 1959, 85–109.—French 1965 requirements estd 187,000 tons C_6H_6, 75,000 C_8. Discussion (typical flow diagrams) of cat reforming, followed by description of aromatics extraction (azeotropic dist; Arosorb; extractive dist; extraction with SO_2; Udex) and purification (cryst; extraction with AgF in HF; complexing with $SbBr_3$, *p*-aminotriphenylmethane, NiCNS and 4-Me pyridine) processes. Methods of obtaining phthalic acids are outlined. V. B.

1108. Butadiene; basis of chemical industries. L. Jacqué and E. de Meeus. *Chim. et Industr.*, 1959, **81**, 341–56; *Bull. Ass. franç. Tech. Pétrole*, 1959, 3–26.—History. Industrial production methods; from petroleum (dehydrogenation of C_4, thermal cracking of C_{4+}); from ethanol; also by dehydrohalogenation of 2,3-dichlorobutene; pyrolysis of *cyclo*hexane and of butane-diols. U.S.A. plants and annual capacity of each (total 1·24 m tons) are tabulated. Chem and physical properties. Applications (polymers and copolymers); Diels–Alder syntheses; halogenation reactions; *iso*sebacic acid; captane (trichlormethylated sulphurized derivative used as fungicide). Estd W Europe requirement in 1961 *ca* 1000 tons/day. V. B.

1109. The analysis and biological assessment of petroleum-based insecticides. A. D. Harford, E. Thornton, and N. G. McTaggart. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 389–402.—This paper describes some of the methods used at the BP Research Station for the assessment and analysis of insecticides. It deals with the biological methods employed using houseflies and flour beetles; it provides details of the ir absorption technique used for the analysis of insecticides. Two examples are given of the combined methods in operation. Full details of the biological and analytical procedures and of the calculations involved are given in the form of appendixes. (Authors' abstract.)

DERIVED CHEMICAL PRODUCTS

1110. Petroleum chemicals in modern life. M. M. Moulin. *Bull. Ass. franç. Tech. Pétrole*, 1959, 77–84.—Lecture.

MISCELLANEOUS PRODUCTS

1111. Europe's first butyl rubber factory. L. Jacqué and Y. Prax. *Chim. et Industr.*, 1959, **81**, 451–8.—Illustrated description of 20,000 ton p.a. plant at Notre-Dame-de-Gravenchon (Seine-Maritime) operating under Esso licence and fed with butane by adjoining Esso (Port-Jerome) and CFR (Gonfreville) refineries. Butane-feed contains 16–20% *iso*butylene, extracted by 65% H_2SO_4 and polymerized (at *ca* −95° C) with isoprene imported from Baton-Rouge. Flow diagrams. V. B.

1112. Fluid coke—fuel for power. Anon. *Petrol. Times*, 24.4.59, **63**, 331.—The fuel, which is composed of small spherical particles, is clean, pours freely, has a low angle of repose, and is produced as an end-product of a new refining process at Tidewater Oil Co's Delaware refinery. The coke is used at the Delaware Power and Light Co's Delaware City Power Station and is moved by compressed air at 90 psig through 5-inch pipelines at 75 tons/hr. The whole output of the station's electric power is for the refinery. The fuel is essentially an all-petroleum-derived material, with a gross heating value of 14,000 Btu. G. A. C.

CORROSION

1113. Corrosion problems with pressure vessels. H. Allen. *Petroleum, Lond.*, 1959, **22**, 140.—With the application of fired and unfired pressure vessels increasing in the petroleum and chemical industries, the problem of corrosion control heightens. Causes of failure in pressure vessels are often corrosion or erosion of the metal. Hydrostatic tests are effective for ascertaining the condition of pressure vessels which have processed corrosive material. M. F. M.

1114. Pipeline protection in the Middle East. Pt 2. Preparing the ground and checking the results. L. R. Sparrow. *Corrosion Tech.*, 1959, **6**, 42–8.—The nature of the soil in different parts of the Middle East is discussed in relation to the cathodic protection of tank bottoms and pipes. The best protection is obtained when the tank rests on a thin high resistance layer over a deep bed of conductive soil. In the Persian Gulf and low-lying parts of Central Arabia, where conditions are worst, tank bottoms are coated with asphalt and supported on earth plinths. All cables, pipes, and tanks in a cathodically protected system must be well bonded. Insulating flanges should be used sparingly. In checking the system potentials to earth must be measured at closely spaced points. When maintenance work involves a break in electrical continuity in hazardous areas the break must first be short-circuited, even if the protection current has been switched off. Marine installations are coated and wrapped and cathodically protected either by impressed current or sacrificial anodes. In outlying areas the metal chosen for use as anodes should not be desirable loot. G. B.

1115. Pipe-wrapping materials for corrosion protection. J. G. Parry and J. R. James. *Corrosion Tech.*, 1959, **6**, 35–7.—Coatings on buried pipelines must form as good a water barrier as is economically feasible and are supplemented by cathodic protection. The pipes are pickled and phosphated at the mill. The enamel coat consists of either coal tar or petroleum asphalt with inert fillers and should be hot applied for buried pipes. Asphalt enamels have a high initial electrical resistance which falls rapidly, while coal tar coatings have a lower initial resistance which falls much less rapidly. The strength of the enamel is greatly increased by an inner wrap which is drawn half way into the enamel. Further improvement is obtained by applying an outer wrap. The coating and wrapping may be applied at the mill, in a yard near the site, or over the ditch. Yard wrapping is the most suitable for British conditions. Line travel application is only practicable for long runs in open country; the only example so far in the U.K. is on the N Wales gas grid. The best wrapping material is borosilicate glass fibre. When pipe lengths are coated before joining the joins are taped with adhesive synthetic rubber tapes. G. B.

1116. Improved mechanical methods of application of protective coatings to buried pipelines. R. D. McClean. *Pipes & Pipelines*, Dec 1958, **3** (12), 37–8.—Fixed head coating and wrapping machines give better control of enamel thickness, less waste of material, and higher production rates than rolling rigs. Pipe lengths pass successively on a carriage through a wire brushing machine, a priming head where primer is applied by a saturated pad, and a combined enamelling and wrapping machine. The pipes have to be uncoupled for drying between the priming and coating stages. The whole operation is carried out under cover. G. B.

1117. The use of plasticized PVC tapes for the prevention of pipe corrosion. J. S. Gerrard. *Pipes & Pipelines*, Dec 1958, **3** (12), 30–2.—PVC pressure sensitive tape is easily applied, even under freezing conditions, and conforms to irregular shapes. With a protective outer wrap it is equivalent to asphalt or coal tar coating. It is particularly suitable for wrapping the ends of stored pipes and joints in pipelines. G. B.

ENGINES AND AUTOMOTIVE EQUIPMENT

1118. Gas turbines for oil industry. L. Walter. *Petroleum, Lond.*, 1959, **22** (1), 11.—In spite of certain limitations and setbacks, industrial gas turbines have become recognized as important and efficient prime movers. Their range extends from *ca* 45 hp to 40 MW. Fuels burnt in gas turbines range from natural gas, intermediate dist, and residual oils, to pulverized coal and peat. Blast furnace gas, methane, and waste gases have been successfully used, and dual fuel burners for natural gas and fuel oil are in operation. M. F. M.

1119. Automobile exhaust gas—the programme of the automobile industry. C. M. Heinen. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 192–8.—A survey of a three-year study on automobile exhaust emissions, conducted by the Vehicle Combustion Products Sub-committee of the Automobile Manufacturers Association, shows that good progress has been made in the analytical field, although a continuous method for the oxides of nitrogen has not as yet been developed; that analysis for individual hydrocarbons still requires considerable study; and that for the problem of daily reduction from the various analytical methods, some type of integrator will probably be required.

In co-operation with the CRC, the Group on Composition of Exhaust Gases, consisting of four panels, was created. The Sampling and Analysis Panel applied mass spectrometric, ir, and other methods to grab-sample analysis and, beyond this, developed continuous analysers and good methods for measuring total organics and carbon monoxide and dioxide. The work of the Variables Panel has progressed satisfactorily with respect to engine variables, but the field of fuels and lubricants is as yet largely untouched. The Field Survey Panel, which applies information obtained from the other panels to evaluate cars operating under actual service conditions, conducted two field surveys, in the second of which cars distributed according to the car population of Los Angeles were run under 13 different operational conditions, oxides of nitrogen being obtained under four by grab-sample methods. At present, data resolution from this survey is still going on. The Literature Survey Panel keeps the CRC groups up to date on latest developments.

The work of the Traffic Survey Group, whose information is to be correlated with that of the Field Survey Panel, is nearly completed. The groups which are studying devices which might reduce exhaust emissions reached the conclusion that, among the induction-system devices, those which maintain the throttle in a slightly open position are the most practical. As exhaust-system devices, afterburner and cat afterburner show promise for organics reduction, and the use of activated carbon might possibly reduce the oxides of nitrogen.

(Author's abstract.)

1120. Study of octane requirements of the existing French car population; discussion as to desirability of. — Merroneau *et al. Bull. Ass. franç. Tech. Pétrole*, 1959, 131–48.—Description of scope and organization of U.K. Co-operative Octane Requirement Cttee, and report of ensuing discussion as to desirability of setting up similar organization in France. V. B.

SAFETY PRECAUTIONS

1121. Intrinsic safety in instrument and electrical circuits. L. E. Cuckler. *Proc. Amer. Petrol. Inst.*, 1957, **37** (3), 309–16.—The demand for electronic and electric instrumentation is continuously increasing in the processing industries. Many of these processes involve flammable atmospheres where the use of electrically actuated primary measuring elements would contribute an explosion hazard if the electrical energy is above certain limits. This paper reviews existing research literature regarding the intrinsically safe energy levels of electrically actuated devices.

A number of factors govern unsafe electric spark ignition energies. These factors are reviewed with regard to their contribution of the ignitability of an electric spark in the flammable gas or vapour mixture. The bulk of the data presented concern Class I, Group C and D, hazardous areas.

The subject is treated from a basic viewpoint covering such aspects as: theory of electric ignition, testing apparatus for minimum ignition energies, formulas for calculating total energy, and a brief review of the factors affecting spark ignition. A number of curves are shown relating the electrical and mechanical characteristics of the sparking circuit, and the flammable characteristics of the gas or vapour as they affect minimum ignition energy. A table summarizes these factors and points the direction which a variable must change to make the element more hazardous in the ignition of a flammable gas or vapour.

It is not intended to leave the impression that the intrinsic safety of an electrical device can be determined from a simple electrical energy calculation. The paper does, however, list the results of recent investigations regarding minimum ignition threshold conditions; these should aid the designer, the user, and the specifications engineer in selecting electrical apparatus for use in hazardous areas. Primary measuring elements having intrinsically safe energy levels will, no doubt, require actual testing for a number of years before the broad principles of intrinsic safety can be applied. These principles must first be understood before they can be properly applied to electrical apparatus. (Author's abstract.)

MISCELLANEOUS

1122. Welding techniques and electrodes for the oil industry. J. W. Sheddon. *Petroleum, Lond.*, 1959, **22** (2), 67.—The article gives a description of certain welding techniques which have been developed specially for the construction of the different types of plant used in oil refineries and similar installations. Many of these special welding operations require the use of the manual metal-arc electrodes in welding carried out at the refinery site or in the pipeline installations. Items specially dealt with in detail include welding of storage tanks, pipelines for the handling of crude oil, chromium-molybdenum castings, and stainless steel piping. M. F. M.

1123. Skin protection against petroleum. C. Starkey. *Petroleum, Lond.*, 1959, **22** (3), 94.—It is well known that skin hazards are associated with petroleum, its distillates, and derivatives. Most employers now recognize the existence of these hazards and the need for preventive action. After describing the structure of human skin, the paper deals with causes of skin injury. These are: (1) physical damage to skin tissues; (2) maceration, or softening of the horny layer of skin; (3) degreasing caused by fat solvents, which causes drying and fissuring of skin; and (4) effects produced by contact with chemicals. The skin conditions which occur amongst employees at petroleum refineries are mainly cases of oil acne and dermatitis. Prevention and protection methods are simple and easy, and these can do much to limit contact with offending substances and consequent risk. M. F. M.

1124. Fiscal regulations for Saharan petroleum. N. Masounabe-Puyanne. *Bull. Ass. franç. Tech. Pétrole*, 1959, 199–208.—Basis is "50/50," and make-up of this is discussed. State gets basic fixed share of liq petroleum ($12\frac{1}{2}$%) and gas (5%) in cash or kind, main balance of State share is profits tax, and method of determining such profits is described, together with other relevant tax measures. References are given to appropriate legal enactments. V. B.

1125. Mining regulations for Saharan petroleum. R. Bouyssou. *Bull. Ass. franç. Tech. Pétrole*, 1959, 185–98.—Prospecting permits (non-exclusive); research permits (exclusive, giving right to concession); production (concession grants, details not yet finalized); transport rules; consequential provisions. V. B.

1126. China's growing oil industry. R. Westgate. *Petroleum, Lond.*, 1959, **22** (4), 127.—China's oil output of 2·2 million tons in 1958 is increasing at an annual rate of 20–30%, and the minimum potential oil capacity is claimed to be 100 million tons p.a. A major oil producing area, not yet fully exploited, is Central Szechwan. One of the test wells in this area is producing presently more than 1500 bd. It is claimed that China's oil shale reserves will ensure an annual output of 68–80 million tons of oil for 50 years. Chinese estimates also put the oil-bearing sand in Karamai areas at more than 250 million cu m. Oil content of the sand in this area, 1500 sq miles, ranges between 6 and 13%. China's first oil pipeline connects the Karamai field with the Tushantzu refinery which is 90 miles away in N Sinkiang. The refinery being built at Nanking now will have a capacity of 3 million tons p.a. Coal tar oils are also to be developed in China.

The article contains a number of good photos of Chinese oil installations as well as an oil map of China. M. F. M.

BOOK REVIEWS

Petroleum. Prehistoric to Petrochemicals. G. A. Purdy. Vancouver, Toronto, Montreal: Copp Clark Publishing Co; New York, Toronto, London: McGraw-Hill Publishing Co. Ltd, 1958. Pp. 492. 116*s.* 6*d.*

Many text-books on petroleum have been produced by oil companies for their employees, but few can have been as ambitious as this. It is intended both as a training manual for the Imperial Oil Company and as a general text-book on petroleum which should be neither too elementary for the serious student, nor so specialized as to discourage him.

It can fairly be said that the book succeeds in this aim, as it gives a lucid comprehensive picture of the technical aspects of the petroleum industry, with particular reference to Canada. It is very easy to read and follow, and at the same time imparts an enormous amount of technical information without unnecessary verbiage. Dr Purdy has had experience in many branches of the petroleum industry and the

book owes much to its single authorship, which gives it a continuity not generally obtained. The style in which it is written, involving short, even staccato sentences, adds to the clarity and is a refreshing change from the turgidity of so many text-books. Considerable thought has obviously been given to the layout of the pages, which generally consist of four inches of typescript with a two-inch margin used for photographs and diagrams. This has the virtue of keeping the visual aids close to the script, making it very easy to follow.

The book covers the story of petroleum from prehistoric days to the present rapidly extending petroleum chemical industry, and while being centred on development in Canada, it gives a broad picture of the whole industry. It starts with a survey of the importance of the petroleum industry to Canada and then gives a fascinating picture of the prehistory of oil and of the early growth of the oil industry. This leads to the development of manufacturing and marketing in Canada, with particular reference to the Imperial Oil Company. A chapter on the nature of petroleum is inevitably at a comparatively low technical level, as it covers such a wide field, including the properties of hydrocarbons and other constituents, and the significance of the composition of petroleum products. The occurrence of petroleum, exploration, drilling, and production are dealt with simply and effectively. The chapters on the refining of petroleum are frequently based on historical developments, this enabling the reader to progress easily from the early simple processes to the more complex processes derived from them. A large amount of highly condensed technical information is given in chapters on the properties and uses of petroleum products, including testing and the significance of properties. The final chapter gives the basis and main features of the petroleum chemical industry, again with particular respect to Canada, and provides a useful introduction.

The technical level of the book is comparatively low, no great basic knowledge of petroleum being assumed, and technicalities are so well explained that any intelligent schoolboy should be able to follow it.

The price is breath-taking (possibly due to the profuse illustration) and is likely to restrict its purchase by intending entrants to the petroleum industry. It will, however, prove valuable for teachers and others who wish to acquire a broad technical picture of the industry, and particularly for training schools in the industry itself.

The clarity of explanation of often difficult technical aspects will doubtless appeal to many whose task it is to teach beginners the basic principles of petroleum technology. C. L. G.

Tanker Directory of the World. Ed. Leonard G. Fay. London: Terminus Publications, 1959. Pp. 308. 60s.

This book, as its name implies, is compiled mainly for those engaged in tanker ownership or management; it is sufficiently informative to be worth the attention of almost all those whose work brings them into contact with tankers.

The reference part of the book contains two comprehensive lists of tankers, and of owners and managers. In the first, ships are listed alphabetically by name and then deadweight tonnage, flag, whether motor or steam, owner, builder, and year of completion are given. The second comprises the names of owners or managers and the ships, with deadweights, under their control.

The book also includes a section of more than 100 pages of general reading. A number of articles have been contributed by the major tanker-owning companies, tracing the histories of their fleets over, in some cases, more than 65 years, and other articles describe the fleets of Canada, France, Germany, Holland, Japan, and Norway.

This section is copiously and excellently illustrated, the subjects covering the whole range from the antiquated but charming *Lumen*, 1889, shown dressed overall to enter port, to the enormous *Tidewater*, 53,000 tons dw. An article on trends in profile gives added point to a study of the photographs. One is struck by the almost complete absence of sheer in some of the most modern ships; the effect on the profile is hardly redressed by such devices as rounding the fronts of the bridge and after structures and giving them raked stanchions.

The book is not intended either for naval architects or for engineers, but a number of articles on technical subjects, such as corrosion of cargo spaces and deck maintenance, are included. A contribution on the speed and strength of large tankers contains the suggestion that owner-operators would obtain a better return on capital investment if their ships were built for rather higher speeds than are customary at present. This would only be true at times when freight rates are high, and a recent survey has shown that under average conditions there may actually be a case for slightly reducing the designed speed of large tankers.

A final comment concerns the complexities of the tanker ownership and management structure. On page 96 is a photograph of a large modern ship in the well-known livery of oil company "A." In the first directory section the owners are given as finance company "B," whose address in another section appears as c/o oil company "A." There are today many examples of arrangements such as this which in themselves create a need for a tanker directory. The book is all the more welcome for being readable, informative, and well-produced. L. B.

Proceedings of the Conference on Molecular Spectroscopy. Ed. E. Thornton and H. W. Thompson, F.R.S. London: Pergamon Press, 1959. Pp. vii + 352.

This publication contains the papers presented at the IP Hydrocarbon Research Group Conference, held in London, February 1958.

22 invited papers were read and are given in full, together with the discussions on them. The subject matter of the papers may be conveniently grouped under: spectroscopic theory and techniques; spectroscopic apparatus; and interpretation and application of results.

Three papers were presented on the practice and application of nuclear magnetic resonance spectroscopy, including one of particular interest to the petroleum chemist. Two papers were presented on the theory and application of Raman spectroscopy, one of which was available only in Russian at the actual conference. Two papers were presented on the interpretation and use of ultra-violet absorption spectra and one on free radicle spectroscopy. Ten papers were presented on infra-red absorption spectroscopy. Half of these dealt with advances in infra-red equipment, operating techniques, effects of solvents, and the presentation of spectra as derivative curves; the other half dealt with the interpretation of infra-red spectra and their application to specific problems.

The remaining papers dealt mainly with the theory of the subject, with one paper on shock tubes as sources.

All the papers, since the conference was intended for practising spectroscopists, assume a fair working knowledge of the subject, but are sufficiently detailed to be of considerable benefit to the chemist who wants to know what information he can obtain from this specialist subject.

The discussion on the training of spectroscopists is short and very pertinent.

The book is attractively printed and illustrated, and the editors have retained the spontaneous atmosphere of the discussion by keeping it in the form in which it took place. R. G.

The Nimonic Alloys. W. Betteridge. London: Edward Arnold, 1959. Pp. xii + 332. 80*s*.

Trade names for alloys abound, but only comparatively few prove so important that they become famous. Monel metal and duralumin are examples of this, and a more recent case is Nimonic, now widely heard on unexpected lips.

Why and how, from the basic 80/20 nickel–chromium alloy, the Nimonic series, of more complex high temperature alloys, has been developed (so that we now have Nimonic 75, 80A, 90, 95, 100, and DS, as well as the Nimocast series for the foundry) is fully described by Dr Betteridge. Dr Betteridge belongs to the research department of The Mond Nickel Company, where, working in collaboration with Henry Wiggin and Company, he has been prominently associated with the Nimonic investigations for many years. He has made admirable use of the opportunities thus afforded to produce an attractive and authoritative book, in which a formidable amount of information is compressed. The wide scope of the book is indicated by the chapter headings:

> Requirements of High-temperature Alloys; The Range of Alloys of the Nimonic Series; Constitution; Analysis and Identification; Hot and Cold Working; Heat Treatment; Physical Properties; Mechanical Properties at Normal Temperature; Mechanical Properties at Elevated Temperatures; Corrosion Resistance; Joining; Nimonic Alloys as Castings; Machining and Finishing; Inspection Methods; Applications.

As is fitting, much the longest chapter in the book—90 pages, a monograph in itself—is that on Mechanical Properties at Elevated Temperatures. Their high creep values, aimed at withstanding the conditions in aircraft gas turbines, are of course the original *raison d'être* of the Nimonics, and their properties in this respect, as well as in others, including normal fatigue and thermal fatigue, are elegantly expounded in this chapter, with the help of numerous curves and tables. Elsewhere, particularly in the chapter on applications, the several directions in which the various Nimonics are used in gas turbines are given in detail. There are also numerous examples of other applications—in paraffin heaters and refinery flare-stacks, to mention only two of particular interest to oilmen.

The book is lavishly provided with tables, graphs, and micrographs, all of excellent quality. It is easy to hold and to read, and is altogether an excellent piece of book production. A list of 144 references at the end facilitates the task of the reader who wishes to follow up particular aspects. The price, although seemingly high, is in fact not excessive in view of the large number of illustrations. It is a work that can be recommended both for reading and for reference. A. L. H. P.

Statistical Summary of the Mineral Industry, 1952–57. Mineral Resources Division, Overseas Geological Surveys. London: HMSO, 1959. Pp. 377. 27*s*. 6*d*., net.

This annual publication of mineral statistics includes much detail of the world's petroleum industry. Covering a period of six years, details are given of production of crude petroleum, natural gasoline, natural gas, asphalt rock, natural asphalt, and oil shale. Figures for refinery outputs for many countries are tabulated, as well as details of exports and of imports of petroleum products. All quantities are in long tons (except natural gas) and, where appropriate, conversion factors are quoted.

Stratigraphical Lexicon of Venezuela. (English Edition). Caracas: Ministerio de Minas e Hidrocarburos, 1956. Pp. 664.

In the last 30 years much knowledge has been gained concerning the stratigraphy of Venezuela. The present volume brings together in convenient form 400 articles, each of which summarizes the knowledge of a stratigraphic unit. For each unit the author of the name is given, then a description of the unit, and finally bibliographical references.

ADDITIONS TO THE LIBRARY

Entries are in subject order arranged according to the Uren "Classification for Petroleum Bibliography," the number preceding each entry indicating the classification and corresponding to that used in the "Library Catalogue" published by the Institute.

020 Library Association Year Book . . . 1959. London, L.A., 1959. 470 p.

040 British Petroleum Company Limited. The Chromatography of gases and vapours: a bibliography. Sunbury, BP, (1958).

080 British Instruments . . . directory and buyers' guide 1959. London, United Science Press Ltd., 1959.

080 Ente Nazionale Idrocarburi. Annual report and balance sheet, 30th April 1958. Rome, ENI, 1958. 256 p.

080 Esso Petroleum Company Limited. Annual review 1958. London, Esso, 1959. 36 p.

090 British Standards Institution. Conversion factors and tables. Part 1: basis of tables. Conversion factors. London, BSI, 1959. 114 p. (BS 350: Part 1: 1959.)

090 British Standards Institution. Sine bars and sine tables (excluding compound tables). London, BSI, 1959. 14 p. (BS 3064 : 1959.)

090 British Standards Institution. Intrinsically-safe remote-control circuits associated with restrained plugs and sockets for use in coal mines. London, BSI, 1959. 7 p. (BS 3101 : 1959.)

090 British Standards Yearbook . . . 1959. London BSI, 1959. 543 p.

090 Council of British Manufacturers of Petroleum Equipment. Chairman's report on the work of the Council, July–December 1958. London, CBMPE, 1959. 26 p.

210 Eilerts, C. Kenneth *and others*. Phase relations of gas-condensate fluids: test results, apparatus and techniques. New York, American Gas Association, 1957. 439 p.

210 Orr, Clyde *and* Dallavalle, J. M. Fine particle measurement. New York, Macmillan, 1959. 353 p.

220 American Chemical Society. *Division of petroleum chemistry*. Instrumental techniques in study of catalysis mechanism: symposium. . . . Boston, Massachusetts, April 5–10, 1959. New York, ACS 1959. 197 p.

220 CHALLENGER, Frederick. Aspects of the organic chemistry of sulphur. London, Butterworth, 1959. 253 p.

220 TOPCHIEV, A. V., ZAVGORODNII, S. V., *and* PAUSHKIN, M. Boron fluoride and its compounds as catalysts in organic chemistry . . . translated by J. T. Greaves. London, Pergamon, 1959. 326 p.

230 AMERICAN CHEMICAL SOCIETY. *Division of petroleum chemistry.* Recent advances in the chemical thermodynamics of hydrocarbons and related substances: symposium. Chicago, Illinois, September 7–12, 1958. New York, ACS, 1958.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. ASTM standards on petroleum products and lubricants (with related information) . . . Philadelphia, Pa., ASTM, 1958. 1214 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. 1958 book of ASTM standards including tentatives . . . Part 6: wood, paper, adhesives, shipping containers, cellulose, leather. Philadelphia, Pa., ASTM, 1959. 1014 p.

270 AMERICAN SOCIETY FOR TESTING MATERIALS. 1958 book of ASTM standards including tentatives . . . Part 8: paint, naval stores, aromatic hydrocarbons, coal and coke, gaseous fuels, engine antifreezes. Philadelphia, Pa., ASTM, 1958. 1600 p.

330 AMERICAN CHEMICAL SOCIETY. *Division of petroleum chemistry.* Chemical aspects of the origin, migration and accumulation of oil: symposium. Chicago, Illinois, September 7–12, 1958. New York, ACS, 1958. 74 p.

610 COXON, W. F. Flow measurement and control. London, Heywood, 1959. 312 p.

610 HARDWICKE, R. E. Oilman's barrel. Norman, Oklahoma, University of Oklahoma Press, 1958. 122 p.

720 AMERICAN CHEMICAL SOCIETY. *Division of petroleum chemistry.* Isomerization and related processes: symposium. Boston, Massachusetts, April 5–10, 1959. New York, ACS, 1959. 115 p.

810 AMERICAN CHEMICAL SOCIETY. *Division of petroleum chemistry.* High energy fuels: symposium. Boston, Massachusetts, April 5–10, 1959. New York, ACS, 1959. 131 p.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1127. Salt plug boundary determinations by gravimetric and seismic methods. (In German.) G. Clasen. *Erdöl u. Kohle*, 1958, **11**, 2–5.—Methods for determining salt plug boundaries are discussed with supporting charts. The torsion balance method is not applicable. Seismic refraction and reflection methods are unsatisfactory. Gravimetric methods give only a rough orientation of the salt plug and its boundaries. This is especially valid for calculating the derivation of the gravity. Interpretation of its results can be improved by including seismic reflection measurement results in the outer space of

the salt plug. This calculation of the gravimeter profiles helps but gives no clear determination. Travel time measurement offers the only method for solving the problem. Before unequivocal results are obtained a series of preliminary conditions is necessary. R. T.

1128. Oilfield access planning. W. G. E. Brown and J. G. Boultbee. *Canad. Min. metall. Bull.*, 1959, **52**, 120–5.—The use of aerial reconnaissance for selecting the most economical route for access road building is discussed. From small scale photographs, for area exploration, major topographical features and general types of terrain can be distinguished. Large-scale photographs show topography, soil types and drainage, and gravel supplies and are used with ground surveys of the chosen route for exact siting of the road. Road construction methods and the difficulties encountered in W Canada are described. G. B.

1129. Geomorphology: new tool for finding oil. L. H. Lattman. *Oil Gas J.*, 27.4.59, **57**, (18), 231.—The study of the genesis of land forms can aid in locating oil. Using aerial photographs, topographic highs due to geological structure can be located from a study of drainage patterns and photographic tone. A slight rise may affect drainage in one of three ways: (1) a new drainage system may form on the high area; (2) streams may be deflected around the area; and (3) drainage may cross the area but show changes in channel form across the high. Relative tone changes can be used to distinguish types of deposit and for locating " haloes " of uncertain origin which exist over some highs. Fractures and other lineaments can also be found on photographs. Examples are given. 9 refs. C. A. F.

1130. Salt domes of East Texas Basin. H. H. Krusekopf. *Oil Gas J.*, 4.5.59, **57** (19), 143.—Salt domes have been known in the E Texas Basin for many years and salt has been produced commercially since 1845. Sulphur is very rare and oil was not found until Boggy Creek was discovered in 1927. There are 17 known piercement domes and at least ten deep domes. Most of the latter produce oil and gas, but the piercement domes were found to be largely barren. Recent wells have revived interest in these, and there is now production from Boggy Creek, Hainseville, Bethel, and Oakwood domes. The geology of the Bethel and Oakwood domes are briefly described. Bethel is situated in NW Anderson County and shows an overhang to the W. Faulting and a rim syncline are known. There are multiple pays in the Woodbine and Rodessa. Hainseville is in Wood County and is probably the largest dome in E Texas. There is a rim syncline and an overhang. Only one well has so far found production, in probable Cotton Valley sand. Depth and cost of wells in the area are high, but possibilities for stratigraphic traps are numerous. Maps and cross-sections illustrate the geology of the fields. 7 refs. C. A. F.

1131. Pennsylvanian of SW New Mexico. F. E. Kottlowski. *Oil Gas J.*, 13.4.59, **57** (16), 148.—There has been little very deep drilling in SW New Mexico and adjacent areas of Arizona. In this region Pennsylvanian marine beds reach 4000 ft and the Cretaceous is locally over 10,000 ft. There are several basins, and many areas are masked by lavas. Much of the structure is complex and only a few detailed stratigraphic studies have been made. By analogy with the traps of the W Texas basin the Pennsylvanian should have prospects in basal transgressive arkose sandstones, bioclastic limestone lenses, and in secondary porosity in limestones. Maps and sections show the geology of the region. C. A. F.

1132. Deep Hunton strike arouses wide Anadarko interest. F. J. Gardner. *Oil Gas J.*, 20.4.59, **57** (17), 169.—Oil possibilities of the deeper parts of the Anadarko basin in W Oklahoma have been enhanced by the discovery of commercial gas in 1 Miller, NE Custer County, which was completed in Silurian Hunton limestone at *ca* 14,500 ft. Total depth was 17,000 ft in the Arbuckle. Trap conditions are uncertain, and the well was located on seismic and subsurface studies. Other Hunton fields are mainly stratigraphic traps. C. A. F.

1133. Two big gassers reward northern oil hunters. F. J. Gardner. *Oil Gas J.*, 4.5.59, **57** (19), 141.—Two wells NE of Fort Nelson in NE British Columbia are reported to be the most important discoveries in W Canada since the Swan Hills finds in 1957. They are 1 Petitot River, only 15 miles S of the NW Territories border, which flowed 6408 Mcf/day on test; and 3 Kotcho Lake, 50 miles ENE of Fort Nelson, which was completed for 5350 Mcf/day. Pay in both wells is Middle Devonian–Slave Point between 6600 and 6700 ft. These may be reef discoveries. C. A. F.

1134. Future outlook for oil production in Argentina. A. Rozlosnik. *World Petrol.*, March 1959, **30** (3), 51.—There are a number of oil-bearing basins in Argentina, and some of these have not been explored in detail. Oil possibilities in each of the main basins are briefly discussed; they are (1) the Chaco–Parana basin, containing proved fields where there are strongly folded anticlines complicated by faulting; (2) the Triassic basins, containing fields with paraffinic base oil; (3) the Mesozoic geosyncline of Neuquen in the Mendoza, La Pampa region, where production has been increased recently; (4) the Gulf of San Jorge basin, the main producing province, where oil was first produced in Argentina after the finding of Comodoro Rivadavia in 1907; (5) the Magellanian basin in Santa Cruz, which has not been extensively explored but which contains a field in Tierra del Fuego; and (6) the Mirihuan basin containing only one producing well yielding heavy oil. There are also two basins of limited area, the Rio Salado and Rio Colorado basins, where limited drilling has been carried out. Exploration is to be intensified. Formerly development was limited to areas adjacent to existing fields, but it is now proposed to carry out exploration in other favourable areas. C. A. F.

1135. Some problems of petroleum geology in Kuwait. A. F. Fox. *J. Inst. Petrol.*, 1959, **45**, 95–104.—The geological succession in Kuwait is related to the successions in Al Hasa and in S Iraq, and points of doubtful correlation are noted. Tectonic history and palaeogeography are briefly reviewed. The origins of the Burgan, Magwa, and Ahmadi structures are examined in detail, a combination of salt intrusion and folding being suggested as a possible cause. The distribution of the crude oil in the three reservoirs is described and selective absorption during migration through sandstone suggested as an explanation. (Author's abstract.)

1136. Australasian oil search enters new phase of activity. W. H. Spooner. *Internat. Oilman*, 1959, **13**, 112–15.—A summary prepared by the Mines Dept shows the present state of exploration on the Australian mainland and islands. G. B.

1137. Molasse basin is the key area. A. A. Heim. *World Oil*, April 1959, **148** (5), 209.—Oil prospects of Switzerland are favourable, particularly in the Molasse basin, which extends NE to SW across the N part of the country. Legislation has hitherto hampered exploration, but a new company has been formed, and work is planned for the near future. Seismic surveys will be essential, and these may show that surface structure shifts with depth. Surface indications are known, and bituminous shale has been worked, but little is known of subsurface conditions because of lack of wells. The Oligocene seems to be the best target, and areas of best prospects are the Jura boundary zone, the central part of the basin, where there are many closed Mio-Oligocene anticlines, and the SE

boundary anticline of the basin. In the bordering area of the Molasse in Germany there is a depleted field at Leoprechting. C. A. F.

1138. Future aspects of petroleum geology in the northeastern part of Yugoslavia. (In Serbo-Croat.) V. Aksin. *Nafta (Yugoslavia)*, 1959, **10**, 49–57.—NE Yugoslavia, which belongs to the Panonian sedimentary basin, is nowadays a proved petroleum region. Generally this region is the first area in the E part of the Panonian basin which yields commercial production of oil and gas. Up to this time satisfying initial results have been obtained which give hope for the possibilities of finding new petroleum deposits. By a detailed description of the geological structure of this region, some aspects of the petroleum geology in NE Yugoslavia and the future possibilities of the region are discussed. Exploration works began in 1949, but with a rather slow speed of development. More intensive works started with the application of seismic activity and exploration drilling. The discovered oil and gas fields are small in extent, as well as in ultimate reserves, but they are very interesting from the geological point of view. (Author's abstract.)

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

1139. Seismic velocity effects may hide organic reefs. D. C. Van Siclen. *World Oil*, May 1959, **148** (6), 178.—Provided a moderate amount of geological data is available, it is possible to estimate the approx magnitude of velocity contrasts and false seismic structures produced by hypothetical limestone reefs. These can be used to predict the size of the " false high " on beds below the reef. An example from the Stamford reef is given. C. A. F.

1140. Oil search activity in Australia. Anon. *Inst. Petrol. Rev.*, 1959, **13**, 147.—A review of oil search activity in all mainland states and in the Australian territories, as at the beginning of March, is presented. A. D. S.

DRILLING

1141. New developments in drilling and producing. Anon. *Petrol. Engr*, Jan 1959, **31** (1), B19–23.—Technological advancements have been made in 1958 in every phase of oil well drilling, producing, and servicing, all with the main purpose of cost reduction. Drilling developments have been in the fields of slim-hole drilling, air/gas drilling, all hydraulic rigs and electric (ac powered) rigs, vibratory drilling, and turbo-drilling techniques. In the production field, during 1958, the growth of lease automatic custody transfer applications (LACT) was huge, and it is predicted that the use of such systems will become more widespread in the coming years. The most significant development in well completion has been the tubingless completion method. Coupled with multiple completions, this technique promises considerable savings in the amount of steel used in new wells.

The long-familiar sucker rod pump is still hard to beat, though the sonic pump may one day be as much in evidence. This pump has successfully lifted crude in the 10° API gravity range and has handled crude with sand content of up to 80%. The methods of secondary recovery (miscible phase displacement) have been studied further, and the results will be translated to working field installations during 1959. M. F. M.

1142. Air cleanout. C. R. Graham. *Petrol. Engr*, Jan 1959, **31** (1), B40.—The Ema field in N Texas is the proving ground for a new cleanout method, using air, which is claimed to be the cleanest, the quickest, and the most effective. The Technical Drilling Service Inc, the developers of this new method, use three chemicals to overcome the problems of working with oil and water while using air. The primary additive is a foaming agent, the second an inhibitor (to combat the corrosion), and the third a lubricity additive for prolonging the bit bearing life. At present time the process is used on wells that have been completed in open hole and most have been shot. High annular velocities are necessary to lift the cavings and large cuttings from the hole in the range 10,000–15,000 ft/min. As the air is at high velocity, the hole is cleared even in extremely large cavities. An increase in production over normal cleanout and a saving in time is anticipated. Average cleanout and deepening requires only 6 hr. M. F. M.

1143. Rubber sleeve core barrel increases recovery. B. L. Austin. *World Oil*, May 1959, **148** (6), 159.—A rubber sleeve core barrel has been introduced which enables cores to be taken in areas where conventional methods gave poor results. A rubber sleeve is pushed into the barrel, encasing the core as it is formed, acting as a cylindrical conveyor supporting the core weight. The sleeve is $2\frac{3}{8}$ inches id and is stretched over a 3-inch core. It serves to contain fractured and soft beds which would otherwise disintegrate, and quality and recovery are improved. Contamination is minimized, but cannot be prevented as invasion can occur before the core is formed. In E Venezuela a sand recovered in " mushy " condition with standard equipment was found to be well compacted in the new core barrel. Details of the operation of the barrel are given; field tests have generally been limited to areas where recovery with conventional coring is low such as parts of E Venezuela, Texas, and Oklahoma. Recoveries of 90% have been obtained in most of these areas. Two new types of core head have been used, with diamond set bits which give rapid penetration in soft sections, ability to penetrate both hard and soft beds, and low cost/ft. C. A. F.

1144. Here's how new additives improve deep well cementing. J. O. Woodson and C. L. Fulton. *World Oil*, May 1959, **148** (6), 171.—Cementing materials used in three deep wells below 19,000 ft in Pecos County, Texas, are described. Cement blends were tested in the lab and in the field, and it was found that, using diatomaceous earth as an additive, large amounts of water could be added to cement slurries without the separation of the solid particles. This was used for density control in each of the wells. Other additives served to decrease setting time and lower water loss. The use of silica flour in the cement blend is recommended for deep, high temp squeeze jobs. C. A. F.

1145. Drilling costs cut by air drilling operations in Kentucky. J. Henning and G. Thomas. *World Oil*, April 1959, **148** (5), 177.—Air drilling has been successful in Kentucky, where fluid entry exceeding 200 brl/hr has been handled. Drilling costs have been reduced in an area where cable tools have been the main drilling method. Because of increased costs, rotary and air drilling techniques were introduced, and these have given increased penetration rates and longer bit life. In one well, penetration rate was increased by eight times that of a comparison well and bit footage was increased *ca* four times. It is emphasized that air drilling operations must be properly planned and supervised; if sufficient compressors and equipment are available, staging is not necessary to clear the hole of influxed fluids during trips. Case histories of wells are given. C. A. F.

1146. Slim hole operations in Canada. W. D. Freeborn and D. R. Wright. *World Oil*, April 1959, **148** (5), 166.—Slim hole completion and drilling methods in the Pembina field, Alberta, have shown a 37% reduction in completion costs and a 20% reduction in total well costs. 25 wells have been drilled with $6\frac{1}{4}$-inch bits, instead of 9-inch, using a mud flocculating agent above 5000 ft. $4\frac{1}{2}$-inch drill pipe was replaced by $3\frac{1}{2}$-inch and drill collars were correspondingly reduced to 5 inches and

4¾ inches. Higher pressure losses in the slim holes required small liner sizes to keep pumps within their pressure ratings. Penetration rate was influenced most by rotary speed, and it was found that equal penetration rates and daily drilling progress could be obtained in the area using 6¼-inch bits instead of the usual 9-inch. C. A. F.

1147. New DST technique yields better formation samples. A. W. Smith. *World Oil*, May 1959, **148** (6), 155.—Nitrogen under pressure has been used instead of the normal water cushion in well tests in the W Texas area. The method gives better formation samples without contamination, there is less rig time, any length of pipe can be recovered, and the mixture is safe to handle. Details of equipment and testing methods are given. Surface drilling equipment, such as blowout preventers, can also be tested with nitrogen for high pressure leaks, a hookwall packer being set in the casing below the surface to blank off the formation. Nitrogen can also be useful as a tracer in water floods, and it has other uses in development where an inert gas is required. C. A. F.

1148. Gilsonite reduces lost circulation when cementing. K. A. Slagle and L. G. Carter. *World Oil*, May 1959, **148** (6), 167.—Lost circulation problems during cementing are discussed, and lab and field investigations into various remedial materials are reported. It was found that, in over 100 cementing jobs, 80–90% fill-up can be obtained by using gilsonite in the cement slurry in zones where only 50–60% can be obtained using other types of additive. Gilsonite is a solid hydrocarbon occurring in the Uinta Basin of Colorado. In weak formations the bridging properties of the material enable 12·5–13·5 ppg slurry weights to be used to give excellent results. Gilsonite also has a good scouring action in removing fluid and filter cake from the hole, and it is compatible with standard additives and cements. Other advantages of the material are listed. Details of field tests are given.
C. A. F.

1149. New muds and techniques improve drilling practices. J. A. Gill and W. M. Carnicom. *World Oil*, April 1959, **148** (5), 194.—Drilling problems offshore from Louisiana include fairly shallow abnormal gas pressures, salt water flows, heaving shales, soft beds, "gumbo" beds, and salt beds. Many of these can be combated successfully using new muds and techniques developed for use in the area. Details of muds used for surface and deep hole are given; in shallow holes, fresh water, low pH mud is normally used. This is expensive and is mainly barged to the site. Gels are controlled with additives such as phosphates and quebracho, and oil may be added. In deep wells some muds are lime-treated and others are calcium inhibited, or low pH red muds are used. Centrifuges have reduced mud costs appreciably by removing barytes. C. A. F.

1150. Drilling fluids of the future taking shape in pits of today. B. Honey. *Drilling*, May 1959, **20** (7), 63–4.—The ideal mud of tomorrow is visualized as having the visc of water, weights of up to 15 lb/gal, stability in temp of 800°–1000° F, together with all the desirable attributes of present muds. Necessary steps towards this ideal are being made today, especially in the introduction of EP lubricants and drilling mud surfactants. Both of these have brought unexpected side-effects. EP lubricants added to mud have caused pumping pressures to drop by *ca* 500 psi. Drilling mud surfactants may cause mud in surface tanks to resemble dough in consistency although readily pumpable and in every way satisfactory.
J. C. M. T.

1151. Tiny particles with long names solve big problems down hole. R. O. Frederick. *Drilling*, May 1959, **20** (7), 55–8.—The development of drilling fluids since pre-rotary days is outlined. Weighting with barite or hematite and awareness of the importance of the thixotropic contribution of bentonites produced the practical muds of the 1920s. Later refinements in the '30s and '40s led to better control of visc, gel strength, and water loss in adverse conditions by suitable additives, and development of lime, oil base, and emulsion muds to combat heaving shales and contaminants such as evaporite beds and cement. More recently an alternative type of mud, originally developed to resist high temp in deep wells, solves the same problems by the incorporation of non-ionic surfactants, electrolytes, and polyanionic fluid loss control agents. These have the effect of causing clay particles to aggregate in orderly plate-to-plate stacks and give a liq with low visc, high stability, absence of gellation at high temp, and resistance to solids build-up. Shale control has been achieved by use of sodium silicate which progressively consolidates incompetent shales, later by means of filtrate fluid containing free calcium ions to convert the clay minerals to non-swelling types.
J. C. M. T.

1152. Recent developments in drilling mud. R. B. Hyde, Jr. *Canad. Min. metall. Bull.*, 1959, **52**, 170–7.—Formulations and characteristics of high density muds for drilling or killing wells under abnormal pressure are given. Methods are described for filling fractured or cavernous zones in which mud is lost. The use of surface active mud for deep drilling and resistance to high temp, of special muds for drilling through shale, and of emulsions and EP lubricants is discussed. It is important that muds should not cause damage to the producing formation or interference with electric well logging.
G. B.

1153. Drilling mud filtration and its effect on the electrical resistivity of porous media. D. L. Flock and H. T. Kennedy. *Canad. Min. metall. Bull.*, 1959, **52**, 178–85.—A lab investigation is reported in which drilling mud was applied under pressure to sand cores containing brine or oil and brine. The manner and rate of penetration, the distribution of solids and electrolytes, and the effect on electrical conductivity were determined. The experiments were designed to assist the interpretation of electric well logs. G. B.

1154. Low-solids muds score high. P. O. Pope and J. Mesaros. *Oil Gas J.*, 4.5.59, **57** (19), 90–5.—Mud programmes of three deep wells in Pecos County, Texas (1-EE University, 25,350 ft; 1-A Montgomery, 23,400 ft; 1-A Harral, 19,020 ft) are described and mud properties at various depths tabulated. Least trouble was experienced in 1-EE University, which used a low-solids oil emulsion mud throughout, thinned with conventional tannin cpds. Properties at 25,000 ft were much the same as at 10,000 ft. Bottom temp of 351° F caused no difficulty. Mud cost/ft was $10.51. On all wells degassers and cyclones were used, and a system of cross-jetting installed in pits to enable settlings to be removed without loss of mud.
J. C. M. T.

1155. Fluid flow rate through perforations. J. W. Kraemer. *Petrol. Engr*, Jan 1959, **31** (1), B44.—For better evaluation of flow capacity of perforations, a series of tests has been carried out by Halliburton Oil Well Cementing Co using ⅜-inch jet, ½-inch bullet, and ⅝-inch jet perforations. Both oil and water were used. The results are indicated in the form of the plot of perforation flow rate against differential head in ft of flowing fluid (on a log–log scale) and they fit the following equations:

$$q = 0{\cdot}0482\ \sqrt{h} \text{ for } \tfrac{3}{8}\text{-inch jet}$$
$$q = 0{\cdot}0962\ \sqrt{h} \text{ for } \tfrac{1}{2}\text{-inch bullet}$$
$$q = 0{\cdot}1422\ \sqrt{h} \text{ for } \tfrac{5}{8}\text{-inch jet.}$$

Tests were also conducted with sand and oil mixtures using the same perforations. Examination of results of these tests

(in the form of a similar plot of log head *v.* log flow rate) showed that test data fell slightly above the fluid references. M. F. M.

PRODUCTION

1156. Production automation. (The Atlantic lectures of the University of Texas, Pt 3). D. R. Patterson. *Petrol Engr*, Jan 1959, **31** (1), B31–7.—Automatic controls are not new to the oil and gas industry, but there has been a growing swing to automation in the past few years. The areas of automation may be broken down to seven categories: (1) automatic well control; (2) well testing; (3) tank switching; (4) lease automatic custody transfer; (5) automatic lease process control; (6) automation supervisory control; (7) office machine automation. These are discussed in the paper.

The primary justification for installing automation systems is always an economic one. A company's profits can be increased in two ways, first, by investing to make money, and second, by investing to save money. Investing in automation can often accomplish both at the same time. The author lists the benefits of automation under tangible and intangible benefits. Capital investment, operating expense, conservation of volume and gravity, and salvage of installed equipment fall in the former group. Greater accuracy, improved reservoir performance, more efficient use of equipment, more efficient use of personnel, relief from inflationary pressures, and increased management control are the benefits included in the latter group. The paper includes a comprehensive literature survey. M. F. M.

1157. Predicting reservoir performance. H. H. Power. *Petrol. Engr*, Jan 1959, **31** (1), B79.—In the past, the prediction of reservoir performance by the use of the material balance and other mathematical means has been affected by the use of the relative permeability concept. It has been found that experimental volumes of relative permeability, as determined in the lab, do not reflect the original and subsequent fluid distribution in actual reservoirs nor the mobility experienced in the reservoirs under usual production practice. Burtchael proposed a solution to the problem by the use of actual pool performance data. Heuer derived a relative permeability relationship for field use in solution gas-drive performance using a log–log extrapolation of cumulative gas *v.* oil production. Muskat proposed differential equations as a basis for the study of a hypothetical reservoir.

The author, after extensive reviewing of the published literature and reproducing a considerable amount of tabulated and graphical data, concludes that data relating to oil reservoirs may be analysed and plotted as it becomes available from initial to final condition of reservoir's performance. Control plots so constructed will indicate the relative efficiencies of recovery under primary and other recovery mechanisms. They should also be of value in the substantiation of performance calculations resulting from solution gas drive, material balance, frontal drive, and other reservoir mechanisms. The extrapolation of data such as that presented in this paper should also be of assistance in the construction and verification of field relative permeability relationships as a function of saturation. The empirical relationships also lend to confirmation and extrapolation at regular intervals by computer techniques. M. F. M.

1158. Interpreting cable tool hole well logs. E. J. Moore and C. Holmes. *World Oil*, April 1959, **148** (5), 142.—Logging methods and interpretation in cable tool wells are complicated by the absence of a marked invaded zone and rapid changes in resistivity of the borehole fluid. It is therefore necessary to log mud resistivity, and a four-electrode device is used which logs *Rm* together with SP, enabling the connate water resistivity to be computed. Effective porosity can be obtained from radioactivity logs using the γ-corrected and neutron curve, and hence the formation factor can be calc. Normal resistivity logs can also be run, if necessary together with focused logs. In gas wells the temp log can indicate the position of gas zones and their rate of flow. A dual-spaced neutron log can also give information on the extent of the gas pays. The caliper log should be used to check the influence of borehole dia on the quantitative interpretation of these logs.

Radioactive tracer surveys aid in evaluating the efficiency of acidizing and fracturing techniques. C. A. F.

1159. Left-over oil "rescued" on Gulf Coast. E. McGhee. *Oil Gas J.*, 20.4.59, **57** (17), 62–4.—In the complex reservoirs of Gulf Coast salt domes, where the up-dip and down-dip limits of the reservoir are seldom known accurately, much oil is normally unrecovered: (1) when active water drive encroaches above the highest well on the structure, or (2) below the lowest down-structure well in fields with weak or no water drive. Plans are made to recover this oil without drilling new wells; several attempts have already been successful. Up-structure ("attic") oil is recovered by injecting gas through a well which has ceased producing, allowing time for the gas to migrate to the crest of the structure displacing the oil downwards, and then allowing the well to produce this oil. Down-structure ("cellar") oil is recovered by injecting a heavy brine which will sink below the oil, at the same time raising the reservoir pressure sufficiently to enable it to be produced when injection is stopped. J. C. M. T.

1160. Weird Belgian Congo gas field is tapped. Anon. *Oil Gas J.*, 20.4.59, **57** (17), 82.—An unusual accumulation of methane has been produced at 100,000 cu ft/day from Lake Kivu, Belgian Congo. The gas is held in solution in company with carbon dioxide in the lower layers of the lake water, which averages 1500 ft deep. The gases are held in solution because of the pressure, the water below 1000 ft holding 0·4 cu ft methane/cu ft. There is no water circulation below 900 ft because of the presence of a heavy saline layer at the bottom of the lake. The gas can be produced simply by lowering a pipe to the bottom and priming it with air to reduce the pressure. J. C. M. T.

1161. What torque on a sucker-rod joint? W. H. Ritterbusch, Jr. *Oil Gas J.*, 4.5.59, **57** (19), 86–9.—Failures of sucker-rod joints often occur as a result of improper tightening. The optimum pre-load is calculated so as to provide a safety factor of $\times 2$ on the values at which the elongation of the coupling by the application of the external load equals the compression in the coupling by the application of pre-load. Suggested values for a range of rod sizes are tabulated. The torques needed to produce these pre-loads when the joints are made are indicated. The best means of applying the correct torque is with air or hydraulic sucker-rod tongs, but even then the optimum pre-load will not be obtained unless joint cleanliness and lubrication are adequate. J. C. M. T.

1162. Bottom hole separators increase production. W. P. Schwoe. *World Oil*, April 1959, **148** (5), 152.—Bottom hole separators have been used in wells in the Rocky Mountain area in order to increase pump efficiency and productivity in gassy wells. Ultimate recovery should also be increased by reducing g.o.r., preventing waste of reservoir energy. Several types of bottom hole separator have been designed and examples of three in use in the area are described with diagrams. All are designed to combat low pump efficiency due to gas locking. Separation is effected by pressure drop, turbulence, and gravity separation, enabling free gas to pass up the annulus to the surface. Wells were selected for separator installation on the basis of pumping liq level and well test data. Case histories of treated wells are described with production charts. C. A. F.

1163. New investigations on heavy oil recovery from sand deposits. (In German.) C. Schmid. *Erdöl u. Kohle*, 1958, **11**, 6–11, 72–5. Pt 1. Mining recovery and water flooding. Pt 2. Heat and solvent application.—Pt 1. The world's great oilfields—without the U.S.S.R.—comprising 82% of available oil reserves, contain 8·8% of heavy oil. This is increased by including the tar sands of N and S America. Visc and sp gr render conventional recovery methods of little effect. In the Wietze field 1·82 million tons of oil have been produced in *ca* 80 years from the Wealden sand—the chief reservoir—equal to *ca* 15% oil recovery. This is due to deposit conditions. Practically no gas is present, the oil sp gr is high (0·935–0·955), also the visc at deposit temp *ca* 20°–25° C is 200–7000 cP and edge-water service fails. *Ca* 35–40% of the oil has been produced by mining methods. An almost complete oil recovery is obtained by washing the oil sand with hot water above ground and returning the washed sand as gobbing material. Repeated heating of the water and sand to 90°–95° C renders the process uneconomical. Oil recovery underground also is uneconomical. In a two-stage process the oil sand kneaded with water to a paste is added to a large vol of water and agitated rapidly. The separated oil—95–97% recovery—is creamed off. Water flooding experiments show that oil recovery from heavy sand is improved by slow operation. Pt 2. Formation heating in the immediate borehole vicinity to reduce visc of heavy oils does not produce unconditionally an increase in recovery degree, but denotes an economic result. In Taufkirchen the daily production rate of a heavy oil of visc 70,000 cP at 20° C was increased notably by admitting steam at 200° C and 16 atm by airlift to the producing wells. Deposit temp near the boreholes was raised from 12° to 150° C. Gases must be conveyed to the deposit in heat-insulated feed pipes to avoid heat transfer to the surrounding formations. An example shows that a drainage surface 100 m radius with sand thickness 15 m, with sand porosity 20% and 65% residual oil cont of sp gr 0·865, 20 million kcal are required for heating the pool from 20° to 100° C, 9% for heating the oil, 91% for heating the formation. The Russians state that hot water at 200° C is the most effective heat carrier and can effect complete oil recovery. Underground combustion *in situ* is discussed as regards procedure and results, and a lab apparatus is illustrated and described for obtaining data applicable thereto. Use of electrical energy as ignition source and admixture with low-boiling hydrocarbons as possibilities for improving flowing capability are discussed. With the latter the finger effect must be considered. 12 refs. R. T.

1164. How to improve your gas lift installations. H. W. Winkler. *World Oil*, May 1959, **148** (6), 162.—Down-hole pressure and temp surveys carried out before installation of gas-lift equipment can give large savings in costs. The pressure survey can give reliable information about static fluid levels, the productivity index, and the depth for the operating valve in a continuous flow installation can be determined from a flowing pressure traverse below the point of injection. A pressure build-up curve is useful in designing an intermittent lift installation. Temp surveys can locate leaks and can be used for locating the operating valve; the use of the temp survey has commonly been overlooked for quantitative work in gas-lift wells. Examples of the use of these surveys are given with charts. C. A. F.

OILFIELD DEVELOPMENT

1165. New charts speed oil property present worth calculations. L. F. Ivanhoe. *World Oil*, April 1959, **148** (5), 174.—Charts are presented which facilitate the calc of the present worth of oil properties. They are useful for rapid qualitative evaluation and can be used to determine appropriate discount factors permitting comparisons between the potential values of a well at different decline rates. Two basic factors are: (1) the estimated rate of decline of the wells, and (2) the interest discount factor for the future income. The basic chart shows a plot of production rate and cumulative production against time, for different rates of decline (as %/year). C. A. F.

1166. North of the Prairies. H. Harvey. *World Petrol.*, March 1959, **30** (3), 55.—Problems of exploration and development in the NW Territories of Canada are outlined. Transport is hampered by muskeg terrain and permafrost in the N, which also restricts building construction because of foundation problems. Helicopters have proved invaluable for reconnaissance and geological mapping, and they are being widely used in the area. Communications are aided by the DEW chain of radar stations which crosses the N at *ca* 50-mile intervals, but navigation can be hazardous because of monotonous scenery.

Oil was first found in the NW Territories in 1920 at Norman Wells, *ca* 1000 miles N of Edmonton, where a refinery has been built; this provides fuel for the Mackenzie basin. C. A. F.

1167. Making Saharan dreams come true. Anon. *Petrol. Press Serv.*, 1958, **25**, 363–6.—The potential importance of Saharan oil and gas resources is shown by the passing of oil—brought by pipeline—through Philippeville *en route* to French refineries. This is the reward for France's sustained enterprise, and may lead to national independence as regards oil supplies and consequent financial relief. Despite difficulties caused by the Algerian dispute, creation of OCRS (*Petrol. Press Serv.*, 1957, **24**, 46) and appointment of a special minister in Paris for the Sahara, show French determination—in face of national political opposition—to pursue development of the Sahara's mineral wealth and petroleum. Crude oil has been produced in Algeria since 1913, but systematic exploration commenced only with creation of BRP (Bureau de Recherches du Pétrole) in 1945. CREPS struck oil and located the Edjélé field—the initial Saharan discovery—in Jan 1956. In July, *ca* 70 km farther W, the Tiguentourine field was discovered. In June 1957 El Abeb Larache, *ca* 50 km SW of Tiguentourine, was discovered. In Feb 1958 Zarzaitine was discovered *ca* 60 km N of Edjélé. All producing wells in this area do not exceed 4750 ft in depth, and sand porosity is good. The oil is virtually S-free and low in wax, with gravity *ca* 43° API, approximating to gas oil. Preparations are under way for commercial exploitation. CREPS hopes to begin exporting in 1960 at an annual rate of 4–5 million tons. Hassi Messaoud field, *ca* 600 km NW of Edjélé, has a pay zone 450 ft thick, but the wells are 10,800–12,800 ft deep. In quality the oil resembles that of Edjélé. Pipelines to the Mediterranean seaboard from Hassi Messaoud will handle 14 million tons p.a. after 1961, when the present scheme is completed. Algeria's needs of petroleum products will be met by a new refinery at Maison Carré. Large gas reserves have been discovered at Hassi R'Mel. R. T.

1168. Italy—a resumé of exploration and production. Anon. *World Petrol.*, March 1959, **30** (3), 62.—Although surface indications of hydrocarbons have been known in Italy for a long time, serious exploration was not started until the 1930s. Later, and following world war II, the use of geophysical methods and extended geological surveys have succeeded in defining several prospective areas, and oil and gas fields have been found. The most favourable areas are the Po River Valley, the Adriatic sub-Apennine area, the Puglie plateau, and SE Sicily. Oil prospects and discoveries in each of these are briefly discussed. Most of the production which comes from the Po Valley basin is dry or slightly wet gas, and one gas and two small oilfields have been found in the Apennine–Adriatic basin. Substantial amounts of oil have been found in Sicily, which is the most active area. The main fields are Ragusa and Gela, which produce from Trias limestones and dolomites. Cross-sections of these fields and production data are included. C. A. F.

TRANSPORT AND STORAGE

1169. Oil transportation preferences—their bases. H. N. Emerson. *Proc. Amer. Petrol. Inst.*, 1957, **37** (5), 16–23.—This paper appraises the comparative use of marine, oil pipeline, transport truck, and railroad tank cars in bulk petroleum transportation in the U.S.A. The general factors determining the selection of transportation methods are service, safety, price, and availability. The underlying specific factors combining in various proportions to influence preference decisions relate to materials, manpower, power, fuel consumption, load factor, terminal facilities, inventories, and costs. Several tables are included to show the relative position of each transportation method. (Author's abstract.)

1170. Diverse trends in ships' propulsion. Anon. *Petrol. Press Serv.*, 1958, **25**, 375–8.—From the 1920s on, steam and diesel power for merchant ship propulsion have been in keen competition. This fight may be challenged by the free-piston and gas turbine-powered vessels. Since diesel power entered the marine field its share in total ships' propulsion has risen from *ca* 4% in 1925 to >37% in 1957. These figures represent world averages for all merchant vessel types. For tankers alone in 1925 diesel power accounted for *ca* 8% and in 1957 for *ca* 47% of total tanker tonnage in service. Tanker expansion increased until 1939, when 53% of the world tanker fleet was diesel-propelled. But in 1948, when global tanker tonnage exceeded pre-war capacity by >½, motor tankers' share had declined to >37%. Over the next five years it recovered to *ca* 50%, contracting after 1955 to reach <43% by mid-1958. In the early 1950s, when $\frac{9}{10}$ of the world tanker fleet consisted of vessels of >20,000 tons dwt—12,000–16,000 tonners preponderating—average engine powers ranged from *ca* 5000 to 7000 hp, with 12–15 knots cruising speed. These requirements were met with steam and diesel machinery, the diesels needing 35–40% less oil fuel for equal power. Shaft power for driving a supertanker at 17 knots is 15,000–16,000 hp, approx the max for a marine diesel on a single shaft compared with max output of *ca* 25,000 hp for a steam turbine. Scaling-up of tanker capacities from 45,000 tons dwt narrows the scope for diesel power; however, power output may be raised by using turbo-superchargers for marine oil engines. The upward extension of the oil engine's power range enhances the advantage of its superior fuel economy. Replacing diesel oil with residuals will reduce fuel bills sharply. Trends for the rival methods in various countries are shown in a tabulation. Independent owners favour diesel-propelled supertankers. R. T.

1171. Technical advances in high strength pipe. W. A. Saylor and A. B. Wilder. *Pipe Line Ind.*, Jan 1959, **10** (1), 26–30.—Steel specifications, welding and testing of pipes, and the causes of failure are briefly surveyed. Large dia pipe is usually made from sheared mill plate, but it is now possible to produce 24-inch grade X52 pipe from coiled plate. Longitudinal pipe seams are are welded. A TV camera is being used to guide the internal weld. Induction welding and gas shielded arc welding are not yet sufficiently developed. When pipelines are tested with gas very long ruptures may occur. This can be prevented by testing with water. The defects causing failure are not completely understood. Fatigue during transport may be a contributory cause. A cheaper method of X-ray inspection has recently been developed. Line pipes with a higher yield strength than X52 grade are becoming available. G. B.

1172. Engineering twin 55- and 43-inch lines. F. E. Culvern. *Pipe Line Ind.*, Jan 1959, **10** (1), 37–42.—Problems encountered in the laying of 8 miles of twin 55-inch and 4·25 miles of 43-inch line to carry wet and dirty gas at 15 psi for the Carnegie National Gas Co along a congested route are described. Selecting and surveying the route took 6 months. All joints were detailed to 0·001 ft on drawings. Bends were made by mitring joints. Launching platforms for internal scrapers were provided and sludge traps were fitted at all sags with a max interval of 2000 ft. Unsupported spans of up to 100 ft, a suspension span of 300 ft, and cantilever supports were used at crossings. G. B.

1173. Transportation by pipeline. A. C. Hartley. *J. Inst. Transport*, 1959, **28**, 33–46.—An historical survey of the methods of pipeline construction. G. B.

1174. Making compressor stations quiet enough to live with. W. J. Severin. *Oil Gas J.*, 4.5.59, **57** (19), 96.—Turbo-charged compressor engine noise creates health and morale problems, resulting in loss of worker efficiency due to fatigue, as well as partial loss of hearing.

At one station the noise level was 113 db and outside the building it was 125 db.

Steps to reduce the noise included covering exhaust systems of all six engines with sound-absorbing material, and a 3-inch thick glass fibre blanket was placed between the roof purlins and wall girts.

Engine revisions included slotting of guards of the discharge leather valves on scavenging pumps to accommodate one long valve strip which would not slap against the guard, removal of one of the three scavenging pumps on the engines, and insertion of truncated cones in the exhaust muffler stack and in the intake-air pipe between air filter and engine.

The noise problem on the National Gas Pipeline was a simpler problem than the above Texas–Illinois one, and was confined to air-intake system to turbine blowers, noise levels being from 97 db to 118 db according to position, and 80 db in nearby cottage area. It was abated by lining the 30-inch air receiver with 3-inch thick ultracoustic glass fibre blanket as used in the Texas–Illinois engine room, noise being reduced to 90 db, and 60 db in the cottage area.

Further abatement was achieved by revising mufflers. Figs show silencing devices on engines with air filters, and exhaust mufflers. G. A. C.

1175. Central hydraulic power systems for power operation of pipeline valves. Pt 1. H. A. Altorfer. *Pipe Line News*, May 1959, **31** (5), 48.—Power-operated pipeline valves have customarily been equipped with an individual power source for each valve. New developments embody a central pressure generating station which is able to supply hydraulic power to any number of power-operated valves located within reasonable proximity. Such centralized power systems present many advantages. They replace all valve gearing, numerous special high torque explosion-proof electric motors, etc. They do not require any maintenance provided that the fluid passages and fluid chambers are clean to begin with. The paper gives various flow sheets and pictures of the system. M. F. M.

1176. New 13,400-hp turbine units remotely operated. M. A. Judah. *Pipe Line Ind.*, May 1959, **10** (5), 26.—On the Texas Eastern Transmission Corpn 24-inch Pennsylvania–Jersey gas line are four 15,000-hp compressor stations each controlling a 13,400-hp station 30 miles upstream. The remotely controlled stations run only during winter peak periods. Each contains a single gas turbine with a thermal efficiency of 20·8% at an ambient temp of 80° F. Efficiency and power output increase at lower ambient temp. The turbine drives a two-stage compressor rated at an inlet vol of 10,830 cu ft/min, with an inlet pressure of 644 psia and discharge pressure of 969 psia.

Instruments are grouped on a console at the control station, to which 15 functions are transmitted. Surge control is automatic. G. B.

1177. Florida line brings new construction and operating ideas in pipelining. Anon. *Pipe Line Ind.*, May 1959, **10** (5), 18–25.—The Houston Texas gas line, with a max dia of 24 inches, was completely covered with polythene tape immediately before lowering into the ditch. The coating resistance proved to be 10^6 ohms/sq ft with between 10 and 21 holidays/mile. The terrain varied from mud to sand and water. Scows were used to carry welding equipment, and the pipe had to be anchored in the water-filled ditches. The pipes were joined at the mill into 60-ft lengths to save on-site welding. A method of river crossing is described. Compressors were of a new design, with the cooling fans driven by the jacket water. Aux gear was placed outside the compressor houses to give more room for maintenance. The line will carry 282 mcf gas/day with provision for increase. G. B.

1178. Five ways to supercharge existing two-cycle engines. R. G. Bolfing and J. F. Todd. *Pipe Line Ind.*, May 1959, **10** (5), 37–41.—The methods used are: (1) conversion of an existing gas compression cyl to operate in parallel with the normal scavenge pumps; (2) a belt-driven blower in parallel; (3) an electrically-driven blower in parallel; (4) an exhaust turbine driving a blower in parallel; and (5) the same in series. Each gives increased power at less cost than the installation of a new engine. The engine had to be overhauled and strengthened. G. B.

1179. What slick coatings will do for flow in small diameter lines. H. Levin and M. Gephard. *Pipe Line Ind.*, May 1959, **10** (5), 32–4.—A smooth internal coating, originally intended for corrosion protection, reduced the frictional loss in turbulent liq flow by 17–25%. The coating, of 5·5 mil total thickness, comprised two baked phenolic priming coats and three coats of thermo-setting phenolic modified epoxy resin. G. B.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1180. Gas turbine applications in the petroleum and allied industries. Anon. *Gas Oil Pwr*, 1959, **54**, 142–4.—Among the refinery processes suited to gas turbine applications are:

Fluid Catalytic Cracking: One turbine drives a centrifugal compressor for supplying low-pressure combustion air to the generator, and another compresses the gaseous product in the gas recovery section.

Fluid Hydroforming: A turbine drives a boost compressor and a centrifugal compressor for recycling the combustion gas. Process gas can be used to increase the output of the turbine, and the exhaust gas may be passed through a heat exchanger.

Butadiene by Dehydrogenation: Turbine exhaust gas is used for cat regeneration.

Acetylene Production: A turbine drives two intercooled compressors which pass the cracked gas to the scrubber and stripper, and the exhaust gas is passed through a heat exchanger to heat the charge gases.

Other uses exploit the use of waste gases as part or the whole of the fuel for a gas turbine. H. C. E.

1181. Which—air or water for cooling in condensation of overhead vapour. Anon. *Oil Gas J.*, 4.5.59, **57** (19), 113.—Factors influencing selection of right cooling medium include coolant supply, weather and condensing temp, installation costs, cost of water treating, power costs, space, and maintenance. Where water is inadequate, air-cooled exchange can be valuable and installation costs are comparable with water-cooling facilities. Water treatment involves scaling, corrosion, and algæ troubles. A table evaluates air *v.* water as cooling medium for condensing methanol at 15 psig. G. A. C.

1182. Compressor-piping design and investigations including application of computers to piping design. R. James, Jr. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 139–54.—Reciprocating compressor piping requires special design considerations. Attention to good design practices in engineering of new installations goes a long way towards eleminating most of the mechanical vibration problem. In addition, suction and discharge piping and surge chambers should be acoustically "matched" or "tuned" to the characteristics of the compressor and flowing media. If not, excessive pulsation, cyl overloading and/or starvation, and poor volumetric efficiency may result. Conventional mathematical methods for acoustic design are unsatisfactory. For this reason, an analogue-computer circuit has been developed for the dynamic analysis of compressor flow phenomena. It is believed that this approach will greatly facilitate the design of compressor piping so that good pulsation damping and optimum cyl loads and volumetric efficiency can be obtained. (Author's abstract.)

1183. Towers with bubble-cap trays. II. (In Serbo-Croat.) M. Sekardi. *Nafta (Yugoslavia)*, 1959, **10**, 89–97.—In the second part of the article factors influencing the performance of bubble-cap trays are discussed and limits of vapour and liq capacities are given. Methods of tray construction and material used for the construction are also discussed. Finally, a design example is given. (Author's abstract.)

CRACKING

1184. Performance of new Durabead and heavy Durabead cracking catalysts. S. C. Eastwood and T. E. Phalen. *WPRA Paper No.* 59-16, 1959.—Commercial experience has shown that considerably less kiln vol is required to burn the same amount of carbon off Durabead as compared to Chrome Bead, while the carbon yield is lower with the former. Calculations showed that it was possible to charge 12% more oil and burn 40% more carbon in a TCC unit filled with Durabead compared to Chrome Bead if the necessary changes were made in the other unit equipment. A batch of heavy Durabead cat has been manufactured and is now undergoing commercial test. This cat possesses all the advantages of Durabead and, in addition, has a higher d. Consequently, calculations have shown that both oil charge rate and kiln capacity can be increased *ca* 50% compared to operation with Chrome Bead cat. Commercial operations confirm these calculations: heavy Durabead cat is available commercially. These new cat permit a substantial reduction in the size and cost of new TCC units. G. W. T.

1185. Romford gas reforming plant. J. Burns and E. R. Stewart. *Engineer, Lond.*, 1959, **207**, 842–5.—Gas from Shell Haven/Coryton (and from liq CH_4), with (max) H_2S ½ ppm, org S 5gr/100 ft³, water dew-point 28° F, transferred 17 miles through 24-inch h.p. steel main. Acceptable at 900/2300 Btu/ft³, three main types, 1000, 1500, 2000 Btu/ft³. Present intake planned for 37½ m therms p.a. Refinery gas and steam react (Ni cat, 650°/850° C) to CO, CO_2, H_2; to give reformed gas of *ca* 315 Btu/ft³. Process (Onia–Gegi plant) is cyclic (4·8 min), heating phase (gases passing to waste-heat boiler, plant self-sufficient in steam) followed by make purge with steam;

reforming phase followed by blow purge. Refinery gas utilization is reforming 40%, heating 10%, cold enrichment 50%. Use of primary flash dist, in place of gas, both as feedstock and for heating under examination. Illustrations and flow diagrams. V. B.

1186. The effect of preliminary heat treatment on the thermal activation and deactivation of platinum catalysts. (In Russian.) A. A. Lopatkin *et al.* *Vestnik Moskov. Univ.*, 1957, **5**, 215–19 (Abstract); *Referat. Zhur. Khim*, 1958, **23**, 76748.—Studies were made of the effect of preliminary thermal treatment on the temp dependence of the cat activity of the platinum cat, containing 0·04 and 4·3% platinum. Preliminary treatment at 700° C increased the activity of the 0·04% platinum cat. Extreme character of the activity *v.* treating temp curve was maintained. Activity of the 4·3% platinum cat was decreased by preliminary heat treatment, particularly at 900° C. Shape of the activity curves for cat treated at 500° C, 700° C, and 900° C was identical with that for an uncalcined cat. G. W. T.

HYDROGENATION

1187. Predict hydrogenation aromatics. A. Bondi. *Petrol. Refin.*, Feb 1959, **38** (2), 161.—A recent calculation by Myazawa and Pitzer has confirmed a simple method for the rough estimation of hydrogenation equilibrium which has been used by Shell Development Co Laboratories for some time. Recourse is made to the effect of resonance stabilization on the heat of hydrogenation (ΔH_h) of unsaturated cpds, using the equation:

$$\Delta H_h = U \cdot \Delta H_h^* - E_R$$

where U is the number of double bonds to be saturated per aromatic mol, ΔH_h^* is the heat of hydrogenation per olefinic double bond of reference olefin, and E_R is the resonance energy of the aromatic mol. Rather good predictions of ΔH_h are possible as shown in data presented in the paper for such cpds as naphthalene, phenanthrene, tetralin, chrysene, etc. M. F. M.

1188. Hydrogenation of Spanish shale oil in the Puertollano works of the national enterprise Calvo Sotelo. (In German.) O. Reitz and H-U. Kohrt. *Erdöl u. Kohle*, 1958, **11**, 18–22.—An illustrated article on the installations in Puertollano, the first in the world in which shale oil is processed on a tech scale by hydrogenation to high-grade power and lubricating materials. Flow diagrams are presented. Products are light and heavy gasoline, kerosine, gas oil, spindle oil, medium and heavy machine oil, hard and soft wax. R. T.

1189. Hydrogenation at Billingham in retrospect. C. Cockram and E. W. Sawyer. *Industr. Chem.*, 1959, **35**, 221–9.—History of hydrogenation processes at Billingham is surveyed. After pilot plant work in 1930–31 full-scale plant was opened in 1935. Original plans laid main emphasis on hydrogenation of coal, but this proved uneconomical, and creosote middle oils provided main raw material. In 1939 coal hydrogenation (max petrol 52,000 tons p.a.) ceased, but creosote hydrogenation (max 180,000 tons p.a.) continued until 1958. Development of new cat, operating conditions, and ancillary processes to keep pace with increased ON requirements of petrol are described; analyses of hydrogenation petrols tabulated. Billingham now produces chemicals from products of cracking of petroleum at nearby Wilton works. W. A. M.

1190. Hydrogenation of heavy petroleum residues and distillates of secondary origin. (In Russian.) V. I. Karzhev. *Khim. Tekh. Topliv Masel*, Dec 1958, (12), 3–9.—A gas oil from cat cracking, a topped dist from the coking of heavy bottoms, and an extract from the selective solvent extraction of a straight-run fraction of 350°–500° C boiling range were upgraded by hydrogenation in a fixed bed of tungsten sulphide at 320°–400° C under 300 atm hydrogen pressure. With a throughput of 1 kg/l cat/hr, the conversion reached 60–70% for fractions boiling above 320° C and 85–90% for the extract; hydrogen consumption amounted to 3–4 wt %, of which over 70% served to saturate the liq products. G. W. T.

POLYMERIZATION

1191. Bulk acid polymerization for motor gasoline. E. D. Kane and G. E. Langlois. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 156–60.—A new process for polymerizing a propylene or mixed propylene–butenes feed to produce high-octane motor gasoline blending stock is described. The process uses phosphoric acid as the cat, but in unsupported liq form rather than in a conventional fixed bed. The hydrocarbon feed and the acid cat are contacted in a novel, high-efficiency, orifice-plate reactor. The main advantages of the process are excellent temp control, high olefin conversion, simplified product recovery, and high operating factor because of the ability to replace spent cat without plant shutdown. Product yield and quality, effects of operating variables, cat life, materials selection, and performance of the process in a 100-bd demonstration plant are discussed. (Author's abstract.)

1192. Anionic co-ordinated polymerization of propylene to atactic and stereoblock polymers having high molecular weight. III. Characteristics of the polypropylene obtained by means of the catalytic system $VOCl_3$–$Al(CH_2CH(CH_3)_2)_2$. (In Italian.) I. Pasquon. *Chim. e Industr.*, 1959, **41**, 534–9.—The polypropylene which is obtained by means of the studied cat system, with a temp varying: $-10° \pm 70°$, contains high percentages (as much as 58%) of the atactic polymer (ether-soluble) and a fraction of stereoblock polymer (*ca* 20%) (*n*-heptane-soluble), being the remaining part constituted by a *n*-octane-soluble polymer. The steric composition of the polymer depends on the way in which the cat is prepared, but it depends very little on the ratio Al/V, with regard to ratios included between 1 and 4. The mol wt of each separated fraction of polymer are very high, being even superior to 200,000 for the ethereal extracts, and as high as 500,000 for the heptanic extracts. The mol wt are regulated by a process of chain transfer, the rate of which is of the first order in comparison with the concn of the monomer and, at least, by another process, the rate of which depends on the concn of the cat. (Author's abstract.)

1193. Stereospecific polymerization of conjugated diolefins. IV. Preparation of 1,2 syndiotactic polybutadiene. (In Italian.) G. Natta *et al.* *Chim. e Industr.*, 1959, **41**, 526–33.—Using soluble aluminium triethyl-vanadium triacetylacetonate cat, crystalline 1,2-polybutadienes having syndiotactic structure have been obtained. The crude polymerization product contains, besides crystalline polymers, amorphous polymers, having prevailingly 1,2 enchainment (70–80%). By varying the Al/V mol ratio products mainly constituted by amorphous fraction (Al/V < 5) or of crystalline fraction (Al/V > 9) may be obtained. Aged cat give products richer in crystalline fraction than fresh cat. The impurities contained in the monomer and in the reagents lower the stereospecificity of the process. Some data on the crystallinity of the syndiotactic polybutadiene obtained with the $AlEt_3$–VA_3 system are reported. (Authors' abstract.)

1194. Influence of hydrogen on the anionic co-ordinated polymerization of propylene and ethylene. (In Italian.) G. Natta *et al.* *Chim. e Industr.*, 1959, **41**, 519–26.—The influence of hydrogen on mol wt and on rate of polymerization has been investigated in the polymerizations of ethylene and

propylene with cat prepared by α-$TiCl_3$ and $Al(C_2H_5)_3$. The decrease of mol wt, in the experimental conditions adopted, depends upon the square root of hydrogen partial pressure, and is independent of the partial pressure of the monomer. The kinetic study of the polymerization in the presence of hydrogen, and the analysis of terminal groups, induce the state that hydrogen causes the hydrogenolysis of bonds existing between cat and growing polymeric chains.

(Authors' abstract.)

1195. Stereospecific polymerization of vinylaromatic monomers. II. Halogen substituted styrenes. (In Italian.) D. Sianesi, R. Serra, and F. Danusso. *Chim. e Industr.*, 1959, **41**, 515–18.—The polymerization of several styrenes in the ring halogen-substituted, carried out by a co-ordinated anionic process, forms polymers having ordered structure. From *o*- and *p*-fluorostyrene and from a mixture of these monomers, isotactic polymers have been prepared, having high or medium degree of crystallinity, high rate of crystallization, and high mp. Easily crystallizable also are the polymers from 2-methyl-4-fluorostyrene. From chloro- and bromostyrenes, *m*- or *p*-substituted, the polymers, though isotactic, do not crystallize in an evident way.

(Authors' abstract.)

ALKYLATION

1196. Transformation of gaseous propylene with sulphuric acid. (In German.) G. R. Schultze, J. Moos, and K-D. Ledwoch. *Erdöl u. Kohle*, 1958, **11**, 12–13.—Pt 2. Reactions in presence of an aux phase.—In Pt 1 (*Erdöl u. Kohle*, 1955, **8**, 402) conversion of C_3H_6 with H_2SO_4 without an aux phase is discussed. Pt 2 presents the olefin reaction with H_2SO_4 using a solar oil, paraffin oil, or kerosine, as aux phase. The paraffin oil is a commercial product with the following properties: colourless, $d^{15} = 0{\cdot}884$, visc at 20° C = 235 cS, at 50° C = 42 cS. The kerosine was fractionated from a diesel fuel bp 200°–250° C. By this method the olefin concn in the liq phase is increased, and thereby the reaction of C_3H_6 with H_2SO_4 to alkylsulphuric acid at the same % conversion, is accelerated notably. Sec reactions are repressed. R. T.

CHEMICAL AND PHYSICAL REFINING

1197. Porosity measurements in a fluidized bed. P. J. Baker. *Ingenieur, 's Grav.*, 8.5.59, **71** (19), Ch 1.—A capacitative method for measuring the porosity of a fluidized bed was developed using an ac bridge. The variation of fluidized bed porosity was determined against bed height and dia for various fluidization velocities and bedweights. These measurements gave an accurate representation of the stream pattern in a fluidized bed and allowed accurate values of the heat and mass transfer coeff to be calculated.

D. C. E. de W.

SPECIAL PROCESSES

1198. Clean-up of jet fuels—electrically. R. W. Stenzel. *Petrol. Engr*, Jan 1959, **31** (1), C20.—Recent investigations by the air branches of the U.S. Armed Services have shown that a considerable proportion of jet aircraft crashes can be attributed to engine failure due to contamination of jet fuels. Presented in this paper is a comprehensive review on sources of jet fuel contamination, and what steps have been taken to effect a cure. An electric treating system has been developed which is capable of removing all suspended matter and contaminants from the fuel even under most unfavourable conditions. This system is described in small detail and the advantages of its use are discussed. M. F. M.

1199. Improve wax manufacture with MIBK. E. A. Pullen *et al.* *WPRA Paper No.* 59-15, 1959.—Four years of commercial operation have shown the improvements to be gained by wax manufacturing with MIBK. The controlled or incremental dilution principle permitted full advantage to be taken of the benefits which wet MIBK offered—higher filtration temp rates, lower solvent ratios, and elimination of solvent drying. These improvements had a direct effect on capital and operating costs and could be applied to existing or new plants. G. W. T.

1200. Get more cracker feed from residue. J. E. Lawson, J. P. Peet, and N. P. Peet. *Petrol. Refin.*, March 1959, **38** (3), 177.—A new improved deasphalting process is being used at Humble's Baytown refinery to recover cat cracking feedstock from crude residua. The process involves the injection of the wash oil near the top of the extraction tower and the introduction of the residuum into the middle. This results in reduced metals content and better and more cracker feedstock. The major requirement for new method of processing is high selectivity for recovery of heavy virgin gas oils containing a minimum of metals and Conradson carbon.

M. F. M.

1201. Sulphur is removed now by new processes. R. J. Phillips and H. G. Napier. *Petrol. Refin.*, Feb 1959, **38** (2), 151.—The first commercial electrostatic desulphurization plant is now in service at Cities Services Oil Co's East Chicago refinery. Tests have shown that the plant can easily meet all process requirements with the sulphur content of the treated product averaging less than 25 ppm. The unit, which is similarly effective in removing arsenic, employs a technique described as "electrostatic mixing," which greatly enhances reaction efficiencies. In the plant the untreated hydrocarbon enters the processing system through a small turbine blade mixer in which it is mixed vigorously with spent alkylation acid (90% strength). It then enters the bottom of the first electrical unit, where sufficient electrostatic mixing ensures completion of oxidn reaction and conversion of sulphur to disulphide. Next comes the neutralization stage (with 10% caustic soda) and electrostatic coalescence. The neutralized hydrocarbon is now water washed and electrically coalesced in a third unit. Any traces of water are removed in a mechanical drier that represents the final unit in the processing scheme.

The paper discusses the new phenomena of electrostatic mixing, the effect of feedstock composition, time, temp, and pressure and the economics of the process. M. F. M.

1202. Fluid phase reduction of pyrite ash. (In Italian.) C. Padovani and G. Salvi. *Riv. Combust.*, 1959, **13**, 270–81.—Gas obtained from the conversion of methane with steam, carbon dioxide, or air was employed in fluid phase reduction tests of pyrite ash in order to produce powder with a high metal iron content for use in reduction processing of organic cpds. By the experiments performed it was possible to determine the best operating conditions, the cheapest type of reducing gas, as well as yield and consumption; the reduced powder reactivity can be brought to the required values by heat or mechanical processing. A semi-industrial pyrite ash reduction plant was designed in detail.

(Authors' abstract.)

METERING AND CONTROL

1203. A portable liquid level detector. J. J. Arlman and H. N. L. Hoevenaar. *Ingenieur, 's Grav.*, 8.5.59, **71** (19), Ch 8.—An instrument is described for the detection of liq levels in metallic cyl. It consists of a Cs 137 radioactive

source and a Geiger-Müller counter mounted in a holder. The gamma radiation is measured with a compact transistorized monitor powered by a small battery. The source is contained in a doubly shielded capsule and has an activity level of less than 1 millicurie. The safety factory of the instrument is of a very high order. By measuring the level and the ambient temp it is possible to obtain an accurate value of the volume and weight of liq at NTP. It is ideal for the level measurement of liquefied hydrocarbons, CO_2, etc., in cyl.
D. C. E. de W.

PRODUCTS

CHEMISTRY AND PHYSICS

1204. Molecular symmetry in *cyclo*pentadienyl thallium and some related substances from their microwave spectra. J. K. Tyler, A. P. Cox, and J. Sheridan. *Nature, Lond.*, 1959, **183** 1182–3.—The symmetries of *cyclo*pentadienyl thallium, *cyclo*pentadienyl manganese tricarbonyl, and benzene trichromium tricarbonyl are demonstrated. The manganese cpd had sufficient vapour pressure at room temp, but the other materials were studied in a Stark modulation spectrometer operated at *ca* 100° C. A. D. S.

1205. Molecular motion of enclathrated compounds as studied by nuclear magnetic resonance. D. F. R. Gilson and C. A. McDowell. *Nature, Lond.*, 1959, **183**, 1183–4.—Results of magnetic resonance studies on urea–hydrocarbon adducts, the hydrocarbons ranging from C_{7-12}, C_{16}, and C_{26}, are presented. With urea adducts the enclathrated hydrocarbon mol rotate with some freedom, or execute torsional oscillations, about an axis parallel to the length of the channel in the complex. In contrast to this, work on the *cyclo*hexane/thiourea adduct shows that the normal rotations of *cyclo*hexane are greatly restricted or eliminated when it is enclathrated in thiourea. A. D. S.

1206. Reduction of boiling points of petroleum products to atmospheric pressure. (In Russian.) M. D. Tilicheev. *Trudy Vsesoyuz Nauch. Issledovatel. Inst. Pererabotke Nefti i Gaza i Polucheniyu Iskusstv. Zhidk. Topliva*, 1957, **6**, 156–73 (Abstract); *Referat. Zhur. Khim.*, 1958, **22**, 75247.—Rules for reducing bp of alkanes to atm pressure, taking into account the number of carbon atoms and the structure of the alkane, are presented. Nomograms are claimed to be more accurate than calculations by the AzNII and the Watson–Wirth Methods. For comparing boiling temp of petroleum products, it is recommended to reduce them not only to 760 mm Hg, but also to other standardized pressures, *e.g.* 50, 10, 1, 0·1, and 0·01 mm. This substantially decreases the error in recalculation. G. W. T.

1207. Flame propagation in a reaction vessel having two chambers connected by a duct. A. Combe, C. Meyer, and M. Thiéry. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1435–80.—Flame propagation and speed of combustion were studied, using homogeneous C_6H_6/air mixtures fired electrically, in cyl and spherical vessels. Speed of combustion could be increased by firing the mixture in an aux chamber connected by a narrow duct to the main vessel. In the case of the spherical vessel the aux chamber could be placed either externally, internally at the periphery of the sphere, or centrally. Effects of variation in size of the preliminary chamber, length and dia of the duct, and composition and pressure of the C_6H_6/air mixture were determined. As compared with a simple cyl vessel, optimum result with an aux chamber showed reduction of combustion time of given vol by 80%. For spherical vessels with side ignition a reduction of 60% and with central ignition one of 35% could be obtained. The phenomena are examined theoretically and qualitatively interpreted.
W. A. M.

1208. Apparatus for the detection of vibrations in combustion chambers. M. Trechans and N. Manson. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1345–6.—To determine the effect of a stabilizing reservoir in the combustion of C_2H_2 in a stream of air, a thin V-shaped Pt wire was mounted in a plane perpendicular to the air flow. Fluctuations in pressure were indicated by variations in the p.d. between the ends of the wire, shown either on a cathode ray oscillograph or an aperiodic galvanometer. Results are shown graphically. It is deduced that a similar set-up could be used to control combustion.
W. A. M.

1209. Effect of carrier gas on katharometer response. W. A. Wiseman. *Nature, Lond.*, 1959, **183**, 1321.—If Ray's original eqn (Abs. **533**, 1959) is valid, then the sensitivity of a katharometer is prop to $1/k_1^{\frac{1}{3}}$ (cf Abs. **901**, 1959). However, it is necessary to qualify the difference $(k_1–k_2)$ by introducing constants which are only approx equal to unity. A further point is that the heat lost from the system by conduction, radiation, etc., can be ignored when dealing with H_2 and He, but not with other gases of lower conductivity. H. C. E.

1210. Modification of a cone-plate viscometer for direct recording of flow curves. W. H. Bauer *et al.* *Rev. Sci. Instrum.*, 1959, **30**, 167–9.—An automatic control device for shear rate acceleration of the cone-plate viscometer has been designed so that flow curves can be obtained automatically as a plot of rate of shear *v.* shearing stress. Flow curves of typical greases exhibiting non-Newtonian and time-dependent properties have been successfully obtained. H. C. E.

1211. The structure of fractions of aromatic extracts. (In Italian.) A. Girelli, M. Nuzzi, and B. Casu. *Riv. Combust.*, 1959, **13**, 257–69.—The chemical structure of fractions of aromatic extracts from the refining of lub oils of different origin was investigated by studying their fully hydrogenated (saturated) products (at 200 atm H_2, 270°–300° C, reduced Ni on alumina cat). In fully hydrogenated fractions the following determinations were made: % of carbon in the naphthenic rings and paraffinic chains, average number of rings per mol, and degree of ramification, by the methods of Waterman and co-workers, and the ir spectra. The ring analysis findings were corroborated by the ir spectra; both, broadly speaking, agree well enough with the results obtained on original extracts (not hydrogenated) by an indirect method described in a previous paper. (Authors' abstract.)

1212. A simple equation of state for gas mixtures and its application to the ternary mixtures H_2–N_2–CH_4. (In Italian.) A. di Cio. *Riv. Combust.*, 1959, **13**, 208–16.—With reference to the method developed by Paoluzi for correlating the variables P, V, T in gas mixtures when for each component an equation of state is observed of the type $p = f(T, V - b) - \frac{a}{V^2}$, it is proposed, in the case of binary and ternary mixtures formed of H_2, N_2, CO, CH_4, to ascribe the value 1 to the general constant of interaction (units: litres, atm °K). Employing the Paoluzi equation for the mixture H_2–N_2–CH_4, in the temp range from −30° to 250° C and pressures up to 400 atm, the discrepancy between computed and measured pressure is seldom above 1%, with a mean of 0·91%; employing the van der Waals equation, in the same temp range and with pressures up to 300 atm, the discrepancy between computed and measured pressure is seldom above 3% with a mean of 2·39%. (Author's abstract.)

1213. Degree of ramification and distribution of completely saturated mineral oil fractions. (In Italian.) M. Nuzzi and A. Girelli. *Riv. Combust.*, 1959, **13**, 197–207.—The determination of the degree of ramification of completely saturated mineral oil fractions (hydrogenated) exempt of foreign elements (S, O, N) on which R_T and $\%_0 C_R$ have been calculated by structural analysis methods, allows the determination of hydrogen distribution of the fractions concerned. Two methods of calculation are set forth by which the above data can be used to obtain the hydrogen distribution in terms of $\%_0 H_R$ and $\%_0 H_P$ (hydrogen contained in rings and in chains) in the average mol of saturated fractions. These procedures are derived from the graphical-statistical ring analysis methods of Waterman and his school. (Authors' abstract.)

1214. Mechanism of the iron–hydrogen sulphide reaction at elevated temperature. F. Hügli, C. M. Hudgins, Jr, and P. Delahay. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 23–30.—The iron–hydrogen sulphide reaction was investigated in the range 427°–760° C. The following observations were made. (1) The law of attack is linear. (2) The rate depends markedly on the partial pressure of hydrogen sulphide but not on the pressure of hydrogen which acts merely as a diluent; hydrogen can be replaced by helium at the same partial pressure, the rate remaining unchanged. (This conclusion does not hold near equilibrium.) (3) The rate of attack is decreased irreversibly by interruption of attack. (4) The film is composed of two layers whose thickness ratio remains constant during attack but varies (the thick layer increases) when the metal is completely consumed.

Most of these observations are incompatible with a model based on control by transport of reactants through the sulphide film (Wagner model), and it is concluded that a surface reaction is essentially rate-determining. Experimental methods are described as follows: (*a*) for rate determinations with a quartz spring balance; (*b*) for control of the composition of hydrogen–hydrogen sulphide and helium–hydrogen sulphide mixtures by thermal-conductivity measurements; (*c*) for structural, magnetic, and chemical analysis of films. (Authors' abstract.)

ANALYSIS AND TESTING

1215. Determination of alkanethiols in hydrocarbons with silver ion and dithizone. R. K. Kunkel, J. E. Buckley, and G. Gorin. *Analyt. Chem.*, 1959, **31**, 1098–9.—Alkane thiols (0·1–1 m mol) in petroleum can be titrated in ammoniacal *iso*propyl alcohol soln with a soln of $AgNO_3$ in *iso*propyl alcohol. Dithizone is used as indicator. Smaller amounts can be determined colorimetrically by adding an excess of Ag dithizonate to the soln in $CHCl_3$ and measuring the extinction at 615 mμ. The precision of the titration is 0·2% and of the colorimetric method, 2%. G. B.

1216. An automatically operating, coulometric titration method for continually measuring small amounts of water in fluids. E. Barendrecht. *Nature, Lond.*, 1959, **183** 1181–2.—By using a modified Karl Fischer soln in which the I_2 is replaced by HI, the water content of a sample can be measured automatically and continuously. I_2 is generated by anodic oxidn and is measured coulometrically. A lab apparatus is described and a typical graph reproduced showing the generating current as the function of the rate of supply of a methanol–water mixture of a definite composition. A. D. S.

1217. Automatic titration of peroxides in petroleum products. J. S. Matthews and J. F. Patchan. *Analyt. Chem.*, 1959, **31**, 1003–5.—The sample is added in small portions to a soln of KI (15 g) in H_2O (10 ml), *iso*propyl alcohol (100 ml), and acteic acid (1 ml) contained in the titration vessel. The liberated I is automatically titrated to a potentiometric end point during the addition. Side reactions with I are thus avoided. The accuracy is within 3% for peroxide numbers (m equiv of active O per litre) >1 and 0·1 peroxide number for lower values. G. B.

1218. The influence of prolonged service at elevated temperatures and pressures on the high-temperature strength of chromium–molybdenum alloy tubing. J. F. Ewing. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 122–38.—The influence of prolonged service at elevated temp and pressures on the high-temp strength of chromium–molybdenum (Cr–Mo) heat-resistant alloy tubing has been evaluated. Creep-rupture tests were conducted with longitudinal coupon specimens machined from the walls of four 5 Cr–½ Mo alloy furnace tubes retired from service after periods ranging from 44,000 to 115,000 hr. These data indicated that no deterioration in creep-rupture strength of the base metal resulted from prolonged exposure to pressure at metal temp of 1100°–1160° F. Similarly, room-temp tensile and impact properties were not changed significantly. Test results of tubular creep-rupture on 5 Cr–½ Mo furnace tubing after 116,640 hr of high-temp service agreed well with the coupon data and showed no significant decrease in high-temp strength. Creep-rupture tests on both longitudinal and transverse strip specimens cut from a highly stressed 9 Cr–1 Mo alloy furnace tube removed after 12,750 hr of high-temp service, indicated no appreciable deterioration in creep-rupture strength. The creep-rupture test data from this test programme on Cr–Mo alloy furnace tubing retired from service have indicated no decrease in creep-rupture strength despite prolonged exposure at elevated temp and pressures. (Author's abstract.)

1219. Determination of carbon and hydrogen in organic compounds. Pt 1. Efficiency of combustion catalysts. (In German.) J. Hovacek and J. Korbl. *Mikrochimica Acta*, 1959, (2), 303–13.—28 cat, some of which had already been used as combustion cat in elemental analyses, were tested for their oxidn activity, the test cpd being acetic acid. For each cat determinations were made of the temp at which no detectable acetic acid appeared in the combustion products and the temp at which the transformation to CO_2 and H_2O proceeded quantitatively. The decomposition product of silver permanganate proved the most effective; for this both the above-mentioned temp were 230° C. G. W. T.

1220. Modification of a cone-plate viscometer for direct recording of flow curves. W. H. Bauer. *Rev. Sci. Instrum.*, 1959, **30**, 167–9.—An automatic control device for shear rate acceleration of the cone-plate viscometer has been designed so that flow curves can be obtained automatically using a X–Y recorder. Flow curves of typical greases and other materials exhibiting non-Newtonian and time-dependent properties have been successfully obtained using this automatic control device. The cone-plate viscometer as modified has distinct advantages for the study of such material. G. W. T.

1221. Engine testing of lubricating oils. M. L. Khanna and J. S. Ahluwalia. *ISI Bull.*, 1958, **5**, 248–54.—The standard methods and specifications for engine testing of heavy duty ICE oils are reviewed with a view to providing test facilities at the NPL of India. 30 refs. G. B.

1222. Equivalent weights of wetting agents. G. Russell and E. Whittaker. *Analyst*, 1959, **84**, 253–4.—Essential features of examination of commercial wetting agents are isolation of active agent and determination of its equiv wt. Method for latter is proposed in which aq soln of pure agent is passed through column of cation-exchange resin. Under given conditions cation- and anion-active agents yield an equiv of titratable acid. Method is claimed to be quicker than alternatives, and average difference from these is ±1·12%. W. A. M.

1223. Determination of platinum in catalysts by a colorimetric method. Ya. E. Shmulyakovskii. *Khim. Tekh. Topliv Masel*, Dec 1958, (12), 56–8.—This method for determining platinum-on-γ-alumina cat involves heating the cat at 1100° C for 30 minutes to convert it to acid insol α-alumina, which is then dissolved in aqua regia and filtered. Stannic chloride is added as an indicator suitable for colorimetric determination. The method requires 4·5 hr for 3–4 samples (which can be as small as 0·1 g) and can be used for quality control in cat production. G. W. T.

1224. Investigation into the adsorption properties of various samples of coke using radioactive tracers. (In Russian.) N.P. Mel'nikova *et al. Khim. Tekh. Topliv Masel*, Jan 1959, (1), 28–31.—A radiotracer method was used to study the adsorption power of different samples of petroleum coke, both in the untreated and wasted form. The coke samples were crushed and left in contact with soln of varying strengths of cobalt chloride containing Co^{60}. Samples were then dried and their activity measured by means of a gamma counter. Results obtained were compared with data on pore structure obtained by the mercury injection method. It was found that coke which had been graphited had the highest adsorption activity, probably due to the fine pore structure. G. W. T.

1225. A stable fraction collector for preparative column chromatography. (In German.) H. Berbalk and O. Szaboles. *J. Chromatog.*, 1959, **2**, 140–7.—A fraction collector constructed from parts obtainable commercially is described. Fractions can be collected at definite time intervals or when definite vol have accumulated. The collection time can be regulated continuously for periods from 4 sec to 2 hr. The regulator, which is susceptible to corrosion, is connected to the column and the collector by means of a cable, so that it can be kept the necessary distance away. G. W. T.

1226. Analytical applications of gas chromatography. 1. Analysis of impurities of technical methane. (In Italian.) M. de Vita, G. Caprioli, and E. Paran. *Chim. e l'Industr.*, 1959, **41**, 292.—An analytical procedure is described for the determination of small amounts of carbon dioxide, ethane, propane, *iso*butane, *n*-butane, and butenes in technical methane, by gas chromatography. (Authors' abstract.)

1227. Effect of carrier gas on the sensitivity of thermal conductivity detectors in gas chromatography. B. A. Scott and A. G. Williamson. *Nature, London.*, 1959, **183**, 1322.—Practical results on the chromatography of alcohols and their mixtures with halogenated hydrocarbons confirm the conclusions of Abs. **1229**, 1959. When A is used as carrier gas the sensitivity varies from large positive values through zero to negative values, whereas when He is used the sensitivity is much more nearly constant. H. C. E.

1228. Alumina as a column packing in gas chromatography. C. G. Scott. *J. Inst. Petrol.*, 1959, **45**, 118–22.—From a study of the absorption properties of alumina in terms of retention vol data for ethane, ethylene, and propane it has been possible to deduce the necessary column packing characteristics to obtain a complete separation of hydrogen and 14 hydrocarbons ranging from methane to *n*-pentane on one comparatively short column operating at room temp. The relationship of the gas chromatographic data to the surface properties of the alumina is also discussed. A. D. S.

1229. Use of katharometers in gas chromatography. M. Eden, A. Karman, and J. L. Stephenson. *Nature, Lond.*, 1959, **183**, 1322.—It is shown from published thermal conductivities that Ray's eqn (Abs. **533**, 1959) leads to very variable sensitivities for various hydrocarbons with A or N_2 as carrier gas. With He as carrier the sensitivity is approx const. Similarly, when the hot-wire temp is kept const (Abs. **901**, 1959), He is again superior as carrier gas. H. C. E.

1230. Elementary analysis by X-ray fluorescence spectrography. C. Raimbault and G. Baron. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1253–64.—Theory of primary and secondary X-ray emission is explained, apparatus for X-ray fluorescence spectrography described, and advantages and disadvantages of this analytical technique outlined. 14 refs. W. A. M.

1231. The ASTM colour scale. Anon. *J. Inst. Petrol.*, 1959, **45**, 153.—The ASTM-Union method which is widely used in the U.K. has not been adopted by the IP. However, in view of members' interest in current changes in this method, brief notes are presented for their information. A. D. S.

1232. Elimination of preliminary depentanization of gasoline prior to hydrocarbon-type analysis by mass spectrometry. H. E. Howard and W. C. Ferguson. *Analyt. Chem.*, 1959, **31**, 1048–9.—A correction can be made for the interference caused in mass spectrometric hydrocarbon-type analysis by the presence of C_5 and lighter hydrocarbons. Peak height *v.* vol % is plotted for each of the light hydrocarbons at each mass number at which it interferes. The vol % of each in the sample is determined by gas chromatography. The corrected results agree well with those obtained after preliminary dist. G. B.

1233. Quantitative determination of nickel in oils by X-ray spectrography. C. W. Dwiggins, Jr and H. N. Dunning. *Analyt. Chem.*, 1959, **31**, 1040–2.—A rapid X-ray spectrographic method for the determination of Ni in concn of a few ppm in petroleum has been developed. The use of a cobalt internal standard minimizes interferences. The primary X-ray source is a tungsten target tube operated at 40 kV and 30 mA. A Geiger counter is used to measure the background intensity and the secondary radiation at the Co and Ni peaks. Iron causes an error of 3% when present in concn of 100 ppm and of *ca* 1% in the concn usually encountered. Calibration curves remain valid for at least one month. The precision is within 0·6% and agreement with other methods is good. G. B.

CRUDE OIL

1234. *neo*Pentane and *cyclo*butane in Western Venezuelan crude oils. C. J. Cvejanovich. *J. chem Engng Data*, 1959, **4**, 170–3.—Analysis of several other W Venezuelan crudes has shown that all contain *neo*pentane in low concn. However, it was found that Bachaquero is unique in that it also contains *cyclo*butane. The concn of *neo*pentane indicated by these analyses corresponds to 0·003% of the crude by vol and is approx the same for all W Venezuelan crudes. The concn of *cyclo*butane corresponds to 0·001% of the crude by vol and is unique to Bachaquero. G. W. T.

1235. Nitrogen in petroleum asphalt. J. S. Ball *et al. J. chem. Engng Data*, 1959, **4**, 167–70.—This paper shows the importance of the nitrogen content through development of three concepts: (1) Most of the nitrogen in petroleum is found in the asphaltic fractions. Some asphaltenes contain as much as an average of two atoms of nitrogen/mol. (2) Nitrogen not only forms an integral part of the high mol wt cpds, but is so firmly combined that, upon pyrolysis, most of the nitrogen remains in the coke. (3) Nitrogen, and consequently asphalt, has significance geochemically as an indication of the degree of maturity or age of an oil. These concepts were developed from the results of the work of API Research Project 52b on the Nitrogen Constituents of Petroleum, as well as other Bureau of Mines projects. G. W. T.

GAS

1236. The natural gasoline story. G. B. Gibbs and C. H. Vervolin. *Petrol. Refin.*, Jan 1959, **38** (1), 165–78.—The story of development of natural gasoline has been related in a most interesting and illustrative way in this article. The reader is taken by the authors to the early days of 1903 when Sutton Brothers laid the first four miles of pipe to transport natural gas to a boiler and found that considerable quantities of gasoline were forming in the sags of the line. No mention of this event was given at the time, as the drips in gas, having no market or value at the time, were considered quite a nuisance. Within 20 years, however, the natural gasoline industry grew to more than 1000 plants, using all the basic processes employed today.

The paper traces early processes between 1903 and 1911 and the commercialization of natural gasoline recovery in the years 1911–20. Brief description is given of compression and absorption processes of recovery, the fluctuations in demand for natural gasoline in the following years, and the economic effect of the depression period (1930–33). The world war years were to see a resurging demand for natural gasoline, and by the end of 1944 the production was up at 320,000 hpd. In the 1950s the position has been hopeful but not very settled. The natural gasoline man is still confronted with the seasonal demand for his products, though his main problem is the low ON. M. F. M.

1237. Remove and recover acetylene. W. H. Stanton. *Petrol. Refin.*, 1959, **38** (3), 209.—Monsanto Chemicals Co at Texas City has facilities for production of ethylene from two plants. One plant cracks propane and the other *n*-butane. Both plants make acetylene as a by-product. The acetylene content of the cracked gases from the propane cracking operation averages *ca* 0·35 lb/100 lb of ethylene and for the *n*-butane cracking operation *ca* 1·0 lb/100 lb ethylene produced. Monsanto also has an acetylene plant at Texas City where acetylene is made from natural gas. Acetylene in ethylene is harmful in styrene production, and it is good economics to remove (or convert it to ethylene) prior to alkylation of ethylene.

The paper outlines the approach to the design method for a plant to remove acetylene by absorption. The method of Souders and Brown was first used to set up a rough material balance, and the more rigid method of Lewis was utilized for calculation of lean oil flow rate and the number of theoretical plates required. Finally, plate to plate, heat and material balance calculations were made.

A sample calculation is included in the paper for the guidance of the reader, and various flow sheets and tables of data facilitate the understanding of the problem. M. F. M.

1238. Transport and sale of Lacq natural gas outside the South-West. M. Lecoeur. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1601–11.—Production of crude natural gas at Lacq is expected to reach 20×10^6 m³/day by 1961; and of purified gas 13×10^6 m³/day; consumption in SW region of France will be *ca* 5×10^6 m³/day. The surplus will be supplied to a wide area outside the SW by a pipeline network (map given). Fluctuations in demand—seasonal, weekly, daily, and hourly—of power stations and of domestic and industrial users are considered. To keep production at max it is important that these fluctuations be minimized. Means of attaining this end can include use of the network as a storage system by varying pressure within certain limits, use of underground reservoirs, and insertion in contracts of the right to reduce pressure or interrupt supplies to a customer. The last course can be used in conjunction with a flexible price structure, certainty of supply costing more. It is envisaged that a combination of the methods outlined will be used, after a careful survey has established the pattern of consumption. W. A. M.

ENGINE FUELS

1239. TLA—new additive for super-octane motor fuel. Anon. *Oil Gas J.*, 18.5.59, **57** (21), 309.—Tertiary butyl acetate, known as Texaco Lead Appreciator (TLA), improved efficiency of TEL in high octane gasolines. Its effectiveness increases with amount of TEL present and with octane level. It is a water white liq ester boiling at 204·8° F, miscible in gasolines from freezing to boiling points, and is practically insoluble in water. TLA produces approximately the same improvement in road ON as in research and motor method and tables show octane improvement and effect.

Cost data show that in region of 100-research-octane level TLA addition is competitive with processing as a means of increasing octane. G. A. C.

1240. "Bihugas" as an engine fuel. (In German.) Anon. *M.T.Z.*, 1959, **20**, 26–8.—Biogas or Bihugas, derived from the fermentation of manure, vegetable refuse, etc., has been used as a fuel for a 120 hp M.A.N. dual-fuel engine driving a three-phase generator. Paper briefly outlines operating experience and presents a schematic diagram of the processing, which provides gas with a methane content of 55·60%. G. W. T.

1241. Normal combustion in engines with controlled ignition. B. Salé. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1040–63, 1157–96, 1279–344.—Combustion was studied in single-cyl IFP-Renault-CNRS, single-cyl CFR, and 4-cyl Citroën 11 CV engines, by measuring pressure and time of appearance of flame at various points in combustion chamber; engines and methods used are fully described. Effects on mean speed of combustion and on cyclic scatter therein of nature of fuel, fuel/air ratio, engine speed, and use of a deflector on the inlet were evaluated, and the results are interpreted statistically and thermodynamically. Influence of other factors on cyclic scatter was investigated, and the phenomenon is discussed in detail. 54 refs. W. A. M.

1242. Thornton Research Centre. Recent work on fuel cleanliness, static, hydraulic shock, and other problems. Anon. *Fluid Handl.*, 1959, 124–6.—Outline of techniques and test rigs used in investigation of efficiency of filters and water separators, anti-static additives, and reduction of hydraulic shock on valve closure, in aircraft fuelling systems. W. A. M.

1243. Radioactive tracers cast new light on fuel distribution. D. E. Cooper *et al.* *SAE Paper No. 6T*, 1959.—Tracers were used to study fuel distribution among individual cyl in two modern V-8 engines. Individual fuel components (both hydrocarbons and fuel additives) were "tagged" with radioactive hydrogen or carbon 14. Components were blended into a commercial-type fuel, and their distribution to engine cyl was determined by measurements of exhaust-gas radioactivity. An exhaust-gas analyser of the cat-cell type was used to measure the quantity of fuel distributed to the cyl. Results reported include the effect of various fuel factors, operating factors, and engine-design factors on the distribution of both whole fuel and its components. A study of octane placement within the boiling range of the fuel showed differences among fuels when rated under accelerating conditions (with "manifold-lag") and when rated at constant-speed conditions with poor fuel distribution. In addition, improvements in engine power, economy, octane requirement, and fuel rating which resulted from improved fuel and TEL distribution obtained with a modified carburettor are discussed briefly. G. W. T.

1244. Trends in the production of high-quality motor fuels. D. Read, M. J. Sterba, and N. R. Adams. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 161–73.—This paper presents data to illustrate the trend towards the manufacturing of gasolines

containing an increased concn of high-purity chemical grade hydrocarbons. Traditionally, the production of petrochemicals and the production of motor fuels have been considered to be two separate branches of the petroleum refining industry. It now appears that the motor fuel manufacturing facilities of the refinery of the future will produce chemical grade components, for use both as motor fuel and as petrochemicals. This will permit the refiner more flexibility in his control of motor fuel quality and the extent of his participation in the petrochemical market. Data are presented to show the chemical composition of refinery pool gasolines and the application of the basic refining processes of Platforming, Penex isomerization, alkylation, and Udex extraction to produce the highest quality motor fuel. The factors which influence the sequence of installation of these refining process units are discussed. (Authors' abstract.)

1245. The behaviour of blends of pure hydrocarbons in cool flames as related to their deviations from linear blending on the performance-number scale. C. E. Boord *et al.* *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 112–19.—Cool flame studies were made on various mixtures of pure hydrocarbons in the motored engine and in the cool flame tube. Analyses were done by gas chromatography. The results obtained from the engine and from the tube were comparable and indicated that substantial chemical interactions occur in the combustion of blends of hydrocarbons. It appears that these interactions not only affect the relative rates of oxidn of the components, but also produce major changes in the preflame product mix. Much additional study of this type is needed before the basic chemical principles governing such interactions can be delineated. (Authors' abstract.)

1246. Knock characteristics of hydrocarbon mixtures. E. J. Y. Scott. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 90–111.—The high C.R. in modern cars ensure that the intrinsic power of the fuel is used as economically as possible; however, the accompanying knock restriction has now become a limiting factor in choosing fuel blends. API Research Project 45 has made substantial contributions towards determining the knock ratings of pure hydrocarbons in the gasoline boiling range. However, detailed information of this nature does not give unequivocal values for the knock ratings of hydrocarbon blends. Thus the ON of a blend cannot always be computed by adding the ON of the blend components in proportion to their relative concn. In 1954 a special committee of Research Project 45 was formed to study the fundamental principles of blending with a view to eventually establishing means for predicting knock ratings of hydrocarbon mixtures. Approx one dozen companies have co-operated over the past four years by contributing hydrocarbons or by rating blends. The severity of engine conditions, used for rating a fuel, has been recognized as an important complicating factor. Thus, in this programme, interaction at various severity levels has been studied. Interaction—manifested as a positive or negative deviation from linearity—has been shown to be a common phenomenon. The purpose of this paper is to report the results of the studies and to indicate some conclusions concerning the effects on interaction of severity level, hydrocarbon class, and anti-knock cpds. Many of the curves observed have well-defined characteristics. A preliminary attempt has been made to rationalize these features in terms of a hypothetical model based on physicochemical principles. (Author's abstract.)

1247. Studies of the chemical reactions which occur in an engine prior to knock. K. J. Pipenberg, A. J. Pahnke, and R. H. Blaker. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 68–89.—Complex chemical reactions in the unburned fuel–air mixture ahead of the flame front in a spark-ignition engine can lead to auto-ignition of the remaining mixture. The rapid rate of energy release accompanying this explosive combustion is responsible for knock. Considerable progress in understanding the causes of knock has come from a systematic study of the chemical reactions which occur prior to auto-ignition. This study has involved the identification of the major reaction products formed before auto-ignition and the use of this information to develop a picture of the overall course of the reactions taking place. Direct chemical analysis of fuel–air mixtures which have undergone pre-knock reactions has been widely used to establish the identity of reaction products. Recently, a spectrometer has been used to follow changes in the composition of the reacting fuel in the engine combustion chamber as pressure and temp conditions which produce knock are approached, thus providing a means for studying pre-knock reactions as they occur. The chemical reaction between unburned fuel and air which takes place in the unburned mixture prior to knock: (1) releases heat and thereby increases the temp and pressure of the unburned charge; (2) results in the formation of new chemical species, some more stable and others less stable than the original fuel mol; (3) results in the formation of highly reactive free radicals which are critical reactants in the auto-ignition process. The relative importance of each of the previous factors in the overall knock process varies with hydrocarbon structure and engine conditions. The initial preflame oxidn of paraffin hydrocarbons leads to organic peroxides, unsaturates, and higher carbonyl cpds and is followed by the formation of hydrogen peroxide, formaldehyde, and carbon monoxide. In these preflame reactions, excited mol are also formed which give rise to cool flame and blue flame radiation. As auto-ignition is approached, the concn of reactive free radicals appears to increase, caused in part by the decomposition of the organic peroxides. Reactions involving these reactive radicals, chain-branching in nature, are involved in the auto-ignition process. TEL is relatively ineffective in inhibiting the early preflame reactions which result in the formation of such well-defined oxidn products as peroxides, aldehydes, and ketones; however, it is extremely effective in inhibiting the critical free-radical reactions, which cause auto-ignition. In contrast, aromatic and olefinic blending components increase octane ratings in a different manner. Aromatics have a chemical structure which is sufficiently resistant to oxidn so that they act as inert diluents during the pre-knock reactions of blends. Olefins have a chemical structure which seems to make them inhibitors of many of the early pre-knock reactions which would otherwise lead to auto-ignition. (Authors' abstract.)

1248. The role of physical factors in knock. E. B. Rifkin. *Proc. Amer. Petrol. Inst.*, 1959, **38** (3), 60–7.—Among the physical factors known to be significant in processes leading to knock and anti-knock action, the most important are time, temp, pressure, surface area, and diffusion. The importance of time, temp, and pressure is easy to see since the occurrence or non-occurrence of knock is determined by the outcome of a race between the advancing flame front and the reactivity of the fuel–air mixture. ON is a measure of the time that a fuel, mixed with air, can withstand given temp and pressures without self-igniting. Recent studies in the MIT rapid-compression machine show how time and ON are related. An increase of one ON in the primary reference fuel series corresponds to an increase of *ca* 1·3% in the length of time before its mixture with air will self-ignite when exposed to a high level of temp and pressure. Physical factors also affect the action of anti-knocks. To suppress knock, metal-organic fuel additives must first break down into discrete particles of metal oxide. This decomposition is controlled by temp and time. Specially designed engine tests show that no anti-knock action takes place when the fuel knocks before the metal–organic cpd decomposes. It has also been possible to show that small differences in the anti-knock effectiveness

of various metal–organic cpds can result from differences in their resistance to decomposition. Although this finding is of scientific interest, it has no practical application. In normal engine operation, temp are high enough to decompose any of these anti-knocks. Important factors controlling anti-knock action include the size of the metal-oxide particles (which determines the surface area per unit of additive), the composition of the particle surfaces, and the ability of reactive substances in the fuel–air mixture to reach these surfaces (diffusion). Extensive studies of anti-knock decomposition in motored engines have shown that the particles vary widely in size but are often smaller than one millionth of an inch. Extensive studies of their composition indicate that specific chemical changes occur when the particles interact with the fuel and air. Precombustion reactions play an important role in this interaction, because they can change the form of the metal oxide. The varying effectiveness of metal–organic anti-knocks in different fuels may some day be explained on the basis of the structure of these particles and the changes they undergo. These same principles can be applied to the problem of anti-knock antagonism. It can be shown, for example, that active sulphur cpds in the fuel react with the fine oxide particles from the anti-knock and convert them to sulphates. The ability of an antagonist to reduce anti-knock effectiveness is closely related to its thermal stability, as can be seen by comparing literature data on the stability of these cpds with antagonism data obtained from knock ratings.

(Author's abstract.)

1249. Effect of composition and storage on the properties of jet fuels. A. C. Nixon. *J. chem. Engng Data*, 1959, **4**, 187–92.—Conclusions to be drawn from this work can be summarized as follows: The storage stability of jet fuels is a function of their composition—generally decreasing in the order straight-run, cat cracked, thermal cracked. Storage stability can be improved by acid treatment and hydrogenation and by restricting the access of oxygen from the air. The formation of insoluble gum decreases filterability but not necessarily in proportion to the amount formed. The effect of insoluble gum on filterability is a function of its microscopic appearance. The presence of insoluble gum has a particularly deleterious effect on low temp filterability when water is also present. Even fuels which appear extremely stable by stability tests cause high temp deposits. The rate of filter plugging (ΔP increase) at high temp can be reduced by the pressure of dispersants, but the practicability of such a measure has not been established. Different fuels and pure components vary in behaviour with respect to the rate of both filter plugging and deposit formation in both coil and filter. As the rates are not necessarily related, it is obvious that the interrelationship of the character of the deposit and the system in which it forms is very important. G. W. T.

GAS OIL AND FUEL OIL

1250. Heavy oil burning. J. S. Clark and G. J. Hudson. *Trans. Inst. mar. Engrs*, 1959, **71** (5), 135–57.—The physical and chemical properties of fuels are considered with special reference to the requirements of fuel injection and the different methods of fuel atomization. The problems of fuel droplet evaporation and combustion and of carbon deposition and the primary combustion flow pattern design and its relationship to the spray are discussed. Two types of combustion equipment are defined, combustors (with enclosed flame) and registers (with open flame), and the special problems of design and performance of these are treated separately. Several practical examples of air registers, both for marine applications and for industrial boilers, are discussed and illustrated. The " stabilized flame " principle is described, with particular reference to its highly successful application in the form of the " Lancastrian " air register for conversion of Lancashire boilers from coal to oil firing. Instrumentation for gas analysis is briefly described. An informative discussion follows this paper. A. D. S.

1251. Treatment of low-grade gas turbine fuels. Anon. *Gas Oil Pwr*, 1959, **54**, 133–5.—Sodium cpds in fuels can be reduced to an acceptable level (<5 ppm) by water-washing. Subsequent phase separation by conventional centrifuge leads to the rejection of some of the fuel as emulsion, which has then to be retained in settling tanks.

To overcome this difficulty a new type of centrifugal separator has been designed. Two similar recycle nozzle type centrifuges are used in series, the aq phase being taken to a re-cycle tank, whence wash liquor is pumped back to the centrifuge. The flow of wash liquor is adjusted so that the oil/water interface is maintained outside the disk stack of the centrifuge, thus ensuring max efficiency. Oils of different sp gr cause a change in the interface position, which, however, can be maintained in the correct position by altering the sp gr of the re-cycle wash liquor by altering its temp.

This system is suitable for fuel oil washing systems and for purification of diesel and steam turbine oils. H. C. E.

1252. Problems of fuel oil with high sulphur content. Anon. *Petrol. Times*, 22.5.59, **63**, 396.—Operating experience at Marchwood Power Station is discussed in using high sulphur content fuel oils, and the method to counteract difficulties by use of chemical additive given. Various modifications were made to boilers, such as fitting of refractory belt to reduce excess air. Injection of ammonia and of pyridene resulted in blockages. Certain proprietary powder additives consisting mainly of magnesium carbonate, crushed to 200 mesh, although expensive, achieved some success; injection of ammonia prior to use of powder was successful. Best results were obtained with dolomite and alternative injection, and experiments will be continued with use of magnesium carbonate. G. A. C.

LUBRICANTS

1253. Some lubrication problems in relation to surface states in different industries. J. L. Groff. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1491–3.—Relative importance of the following factors in problems of lubrication of rubbing surfaces is reviewed: relative speed, applied load, temp, amount of play, nature of surfaces and their state, and ambient medium. Two lines of research are possible, according to whether it is desired to protect the original surface finish from wear or to polish the surface by machining. W. A. M.

1254. Lubrication by solid film and friction of hard materials. M. Seal. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1349–59.—After an outline of Bowden's theory of solid film lubrication, results of experiments on the friction of graphite, MoS_2, talc, and boron nitride on Pt surfaces in air are presented. It is shown that effects of adsorbed gases and of oxidn at high temp are important. Friction of graphite on Fe, Ni, Cu, and Au under vac was also studied, and effects are explained. In polishing of diamonds by powdered diamond existence of " grain " has long been recognized. This is now shown to be due to relatively small directional differences in friction which give rise to high temp when polishing in certain directions. These temp are high enough (1000° C) to cause allotropic modification to amorphous C. W. A. M.

1255. Stabilization of mineral lubricants thickened with low molecular weight poly*iso*butylene. (In Russian.) M. A. Mullin *et al. Khim. Tekh. Topliv. Masel*, Jan 1959, (1), 49–52.—Studies were made of the effect of nitrogen and sulphur-containing cpds on the depolymerization of poly*iso*-butylene used as a thickener for mineral oils. Alkyl phenyl sulphides prevented this reaction, and therefore could be used

as stabilizers. The most effective was *para*tertiary-butyl phenyl sulphide; 1% by wt of this substance almost completely prevented the depolymerization of poly*iso*butylene (16,400–36,100 mol wt). G. W. T.

1256. Alteration of the properties of thickened lubricants on heating. (In Russian.) V. N. Gusevskii *et al.* *Khim. Tekh. Topliv. Masel*, Jan 1959, (1), 53–9.—Changes in visc and acid number of soln of "Vinipol" and polymethacrylate in oils when heated to 150° and 200° C for 40 hr were investigated. A fall in visc and an increase in acid number of the thickened oils were observed. The acid number of the thickened oil increased more rapidly than that of an unthickened oil. The addition of *p*-oxydiphenolamine to "Vinipol"-thickened oils significantly reduced the fall in visc of the oil on heating, especially at 150° C. G. W. T.

1257. Designing an automatic transmission fluid. A. J. Bozzelli. *SAE Paper No. 13T*, 1959.—Paper covers the various performance properties a fluid should have, together with the proper selection of components. Lab test facilities were applied to cover the selection of each major component. It was shown that: (1) a vi improver of the intermediate mol wt range provided optimum properties of low temp fluidity and shear stability; (2) the base oil should be largely of high vi, oxidn stable type; (3) the fluid should contain a seal swelling component; (4) recommendation was made for closer co-operation between transmission manufacturers, seal suppliers, and fluid suppliers to develop a significant test procedure for evaluating seal shrink and a standard seal cpd; (5) choice of the detergent-inhibitor materials for a fluid could have a great effect on performance; (6) inhibition of the fluid not only affects total fluid life but also the anti-squawk life. G. W. T.

1258. Probing the causes of piston-ring wear by the radiotracer technique. R. Abowd. *SAE Paper No. 8U*, 1959.—Paper describes three successful radiotracer projects. The first illustrates the use of a technique to discover the cause of ring wear occurring during abnormal combustion. Continuous pre-ignition caused extremely high adhesive wear of top piston rings, but engine knock had no influence on adhesive wear. The effect of dispersant oil additives on the adhesive wear of top-chrome depended both on their type and concn. Iron side wear was also affected by these additives but to a lesser degree. Data on chrome-face wear of top piston rings was collected in a fleet test to provide data on octane requirement increase and spark-plug fouling. G. W. T.

1259. Dry friction and wear in relation to the physical and chemical properties of the surface and underlying layers. G. Bellanger. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1481–4.—Experiments on dry friction and wear of low alloy and mild steels gave curves having three regions. In the first region coeff of friction is low and wear slight, mainly oxide or other surface film. In second region coeff of friction and wear rise rapidly, product of wear being metallic particles. In third region coeff of friction falls somewhat but wear continues to increase and product reverts to oxide, etc. Theory is developed to account for these phenomena, mode of action of doped oils is indicated, and importance of ambient atm is shown. W. A. M.

1260. Wear of large marine diesel engines and the application of emulsified cylinder oil. J. van der Zijden. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1485–90.—Large marine diesel engines operating on heavy fuel oil suffer from excessive cyl and piston wear and fouling of inlet and exhaust ports. Wear is due mainly to corrosion by H_2SO_4 and abrasion by corrosion products, metallic particles, ash, and carbonaceous matter from incompletely burned fuel. The H_2SO_4 is formed from SO_3 produced by combustion of S cpds in fuel oil, either directly or more importantly by peroxidic oxidn of SO_2, and its reaction with lub oil or incompletely burned fuel oil assists formation of abrasive C. Use of heavy duty lub oils gives only slight improvement; doubling concn of additives therein reduces wear but does not reduce fouling and is uneconomic. Both wear and fouling can be reduced considerably (by up to 80%) by using lub oils emulsified with aq soln of salts of bivalent metals, *e.g.* Ba, Ca. These react with H_2SO_4 to give volatile org acids and neutral, non-abrasive sulphates. Suitable emulsifying agents (not specified) give emulsions stable at −20° to +30° C for >12 months and at +50° C for >6 months. (*cf* Abs. **128**, 1957.) W. A. M.

1261. Direct friction in oil: relation between surface state and friction and wear. A. Marcelin. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1360–72.—The terms "surface state," "friction," and "wear" are defined in detail and the theoretical aspects of direct friction in oils examined. A "centipede" machine, in which six disks, which could be independently loaded, were in contact with a rotating shaft, was used to establish basic laws governing friction and wear. The machine was also used to study wear in hot oils and in doped oils. Finally, distinction is made between visc and oiliness; former is solely property of the fluid, whilst latter is a composite characteristic involving both the fluid and the rubbing surfaces. W. A. M.

1262. Material transfer in monomolecular layers of a boundary lubricant. G. L. Gaines. *Nature, Lond.*, 1959, **183**, 1110.—Experiments designed to detect the transfer of: (1) K ions from a mica sheet in contact with mica coated with a monolayer of stearic acid; (2) stearic acid from monolayers on mica to another mica surface in contact, using radioactive elements, are reported. K-42 was formed in mica by ion exchange, and the stearic acid contained the $^{14}COOH$ group. It was found that transfer of both K and COOH took place.

That mol can move from monolayers on one member of a sliding couple to the other member is important in the protection of surfaces. Likewise the possibility of transferring metallic ions either through a lubricant monolayer or by formation of a metallic salt will have to be considered in problems of boundary lubrication. H. C. E.

1263. New method for evaluating the behaviour of transformer oils in service. (In Russian.) K. I. Ivanov *et al.* *Khim. Tekh. Topliv. Masel*, Dec 1958, (12), 46–8.—This method consists essentially of following the aging of the oil in a specially constructed transformer: first for 100 hr to determine the tendency of the oil to form low mol wt water-sol acids and then for an additional 650 hr for the behaviour in prolonged service. Studies were made on the influence of the method of refining an oil on its working properties, the effect of an electrical field on the aging of oils, and the effectiveness of a number of antioxidant additives. Test data on various oils with and without 0·3% 2,6-*di*-tert-butyl-4-methylphenol are included. G. W. T.

1264. Influence of ferric naphthenate on the thermal breakdown of polymers in thickened oils. (In Russian.) C. Z. Kaplan and B. A. Sesekin. *Khim. Tekh. Topliv. Masel*, Feb 1959, (2), 34–7.—Soln of poly*iso*butene, "Vinipol," and polymethacrylate in turbine oil 22L were examined in the presence of ferric naphthenate and benzoin at 50° in an oxygen atm, and in the presence of ferric naphthenate at 150° in oxygen and in air. It was established that in all cases ferric naphthenate contributed to polymer breakdown and also that a free radical mechanism was involved at high as well as low temp. G. W. T.

1265. Mechanical breakdown of solutions of poly*iso*butene in mineral oils. (In Russian.) K. I. Klimov and P. P. Zarudnii. *Khim. Tekh. Topliv. Masel*, Feb 1959, (2), 37–43.—Studies were made of this breakdown in relation to

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shearing stress, rate of shear, temp, concn of polymer, and visc of solvent. It was found that for a given shearing stress there was a critical value of the mol wt of poly*iso*butene above which the polymer bonds started to break. The extent of breakdown is determined by the magnitude of the shearing stress. The final value of the mol wt of poly*iso*butene after breakdown depended on the shearing stress and not on the original mol wt. Knowing the max shearing stress, the optimum mol wt of the polymer can be determined.

G. W. T.

1266. The consistency of semi-fluid greases. J. O. Cliffe and J. W. Pearson. *J. Inst. Petrol.*, 1959, **45** (424), 111–17.—Work has been carried out on semi-fluid greases to establish levels of consistency, as assessed subjectively by a consumer, and to relate these levels to lab tests which purport to measure some aspect of consistency. Seven types of grease were examined and consistency ratings likely to be accorded to the various samples of a given grade by an "average consumer" determined by a panel of nine judges. A summary of methods for measuring the consistency of semi-fluid greases is presented, and from this list a number were selected for further study. Results of lab tests were plotted against the subjective hardness ratings, and the following conclusions were drawn. Stiffer grades of these greases can be controlled by IP 50/56, whilst the plunger rheometer provides a more realistic control for the softer greases. The MacMichael viscometer is of little value for controlling consistency, and penetrations of the tapered hole disk or cyl are of only limited application. A "universal cone" developed after this work was completed should extend the range covered by IP 50/56. A brief account is appended of the test methods employed. A. D. S.

1267. The causes of gelling of sodium-based lubricating greases. (In German.) G. H. Gottner. *Schmiertechnik*, 1959, **6**, 15–20.—Gelling is a highly undesired phenomenon, but until recently it was difficult to guard against it, as the causes were unknown. Extensive research with sodium-based greases has shown that it occurs only when the grease contains a certain amount of substances with hydroxyl groups. Gelling is favoured if the grease is neutral or acid, if the base oil has low visc and high aromatic content, and if it has been poorly mixed. By eliminating these conditions, it is possible to eliminate gelling, even when the grease contains a critical concn of hydroxyl group-containing substances. G. W. T.

1268. Bearing and seal development. S. Gray. *Mech. Engng, N.Y.*, April 1959, **81** (4), 76–80.—Investigations reported cover the following aspects: operation of bearings at speeds to 140,000 rev/min with reference to lubricants suitable for bearing temp to 625° F and problems of wear and vibration, development of 1000° F bearings of several high temp materials with reference to the value of powdered lubricants, capacity, wear and friction, and the dry operation of high-speed, high-temp shaft seals. Briefly dealt with are the oil-throwaway lubrication of bearings at 800° F using conventional type lubricants, the use of Freon 12 refrigerant in the liq and vapour phases as a bearing lubricant at −18° to +100° F, and the development of a Freon 12 shaft-seal design for an aircraft-type refrigeration compressor. A. D. S.

BITUMEN, ASPHALT, AND TAR

1269. The structure of asphaltenes from bitumen. (In Italian.) G. Corradini, A. R. Giona, and E. Mariani. *Riv. Combust.*, 1959, **13**, 187–96.—Ir spectra were made of asphaltenes from natural and petroleum bitumens, and from tar. After identification of the probable origin of the various bands observed, the differences between the natural and artificial products were evidenced, as well as the influence of oxidn processes. Stress was laid on the structural relationship between bitumen asphaltenes and extracts obtained with solvents from coals.

(Authors' abstract.)

1270. Investigation of bitumen structure with the electron microscope. (In German.) M. Freund and S. Vajta. *Erdöl u. Kohle*, 1958, **11**, 13–18.—An electronmicroscopic replica method is described which replaces conventional methods with a contrast-rich metal transfer. By this method fineness or differentiation of surface structure of bitumen samples produced from Nagylengyel petroleum by different processes is revealed. The structural elements of the bitumen in the sol state or on its borders are shown in the pictures to be of coarser construction with blurred contours. With increasing gel character a surface is unfolded consisting of ever smaller, more complicated structural parts which seems to be also more sharply defined. Also the progressing change of the sol condition into the gel condition on blowing the bitumen was traced by using the described method, and proved by chem and rheological val. Thixotropic occurrences could also be detected or studied. Generally the microscopic exposures of the surface structure appear to bring new interesting information on the colloidal structure of bitumen. 19 refs.

R. T.

1271. Asphalt emulsions in highway work. C. M. Hewett. *Rds & Str.*, 1959, **102**, 198.—Asphalt emulsions are now recognized as one of the most useful asphaltic road binders for both new roads and maintenance, and great improvements in quality and uniformity have been made during the past 15 years. Rapid setting grades are high visc products which give good retention of coverstone during early traffic, and these are in most common use. Second most widely used grade is the slow setting type with an asphalt content of 57–62% and is used with graded local or commercial aggregates, even when these are damp.

Medium-grade emulsions are used with open graded aggregates for patching, levelling courses, and stockpile pre-mix.

A table shows relative specification preferences for RS-2 asphalt emulsions. G. A. C.

SPECIAL HYDROCARBON PRODUCTS

1272. Milk as an eluant of polycyclic aromatic hydrocarbons added to wax. H. L. Falk, P. Kotin, and A. Miller. *Nature, Lond.*, 1959, **183**, 1184–5.—Carcinogenic hydrocarbons such as 3,4-benzpyrene and 1,2,5,6-dibenzanthracene, which were added to a hydrophobic wax, could be eluted from the wax using milk as the eluting agent. The fat content of the milk had no effect on its efficiency as an elutriant.

A. D. S.

1273. The determination of average molecular weights in connexion with the structural analysis of insulating oils. (In Serbo-Croat.) V. Tisler. *Nafta (Yugoslavia)*, 1959, **10**, 58–61.—For determining the structural analyses of insulating oils, the *n–d–M* method is applied, among others, where the knowledge of the average mol wt is necessary. Comparing the various determinations of average mol wt of a sample of transformer oil by the cryoscopic and ebullioscopic methods, it has been stated that by correct choice of the ebullioscope the ebullioscopic determination of average mol wt is more accurate than the cryoscopic determination.

(Author's abstract.)

DERIVED CHEMICAL PRODUCTS

1274. The petrochemical story. T. C. Ponder and F. L. Evans. *Petrol. Refin.*, 1959, **38** (1), 179–87.—The beginning of the petrochemical industry was *ca* 1916, in which year Carlton Ellis discovered a method for making *iso*propyl alcohol from

petroleum raw materials. Realizing the growth potential of converting oil into chemicals, Standard Oil Co of N.J. acquired the Ellis patents in 1919 and constructed the first large petrochemical plant at Bayway (N.J.). An important discovery was made in 1929 which enabled conversion of olefins into olefin oxides by direct oxidn. With this discovery the door was open for the manufacture of polyols. Then in 1930 a reaction was discovered which led directly to the creation of the large detergent manufacturing industry. This reaction is the formation of secondary alkyl sulphonates by direct sulphonation of paraffins with SO_2 and chlorine. By 1932 ethylene production was becoming a fairly large and stable process. A year later polyethylene became a reality. This was followed by discovery of processes which yielded butadiene and *iso*prene from which butyl rubber was made in 1940. Plastics came to the scene in middle 1930s, and in 1938 du Pont & Co first introduced nylon.

The truly dramatic growth of the petrochemical industry seems to have started during the second world war. Since then numerous new materials, too many for individual mention, have been produced and have found wide-scale use in modern living. The article describes in some detail the activities of major American companies engaged in manufacture of petrochemicals in post-war years, together with some useful statistics on production of different materials.

M. F. M.

COAL, SHALE, AND PEAT

1275. The nature of coal. J. W. Whitaker. *Nature, Lond.*, 1959, **183** (4673), 1438–40.—An account is given of a symposium on the nature of coal which was held at the Central Fuel Research Institute, Bihar, during 7–9 Feb 1959. The main subjects of the symposium were the origin and formation of coal, petrographic studies, X-ray structure, the constitution of coal as revealed by physical or chemical methods, and the physico-chemical properties of coal. The proceedings of the symposium are to be published in book form. A. D. S.

MISCELLANEOUS PRODUCTS

1276. Butyl, modern synthetic rubber. W. J. Sparks. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1265–78.—Poly*iso*butylene has a long chain structure which differs from that of natural rubber by reason of its saturation. Co-polymerization of butylene with isoprene yields a long chain mol with a small number of double-bonds. These enable the modern " butyl " to be vulcanized successfully and enhance the effects of fillers. Physico-chemical properties of butyl and natural rubbers are compared, and development of butyl rubber for inner tubes and, more recently, for motor tyres described. The future of butyl rubber is briefly considered. W. A. M.

1277. Powders for self-propulsion. G. Reure. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1582–9.—Brief review of theory of self-propulsion is followed by survey of principal energetic and kinetic characteristics of propellant powders, which may be single cpds or mixtures. Methods of manufacture are outlined. W. A. M.

1278. Chemical nature of liquid propergols. Boranes and their preparation. P. Duhaut. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1563–81.—Requirements of suitable liq fuel systems for rockets are surveyed, and it is concluded that boranes are the most promising as energy sources. Methods (some new) of preparation of boranes are given and their stability indicated. Diborane is the key to preparation of higher hydrides and is produced from BCl_3 or BF_3; preparation and properties of these halides are briefly surveyed. W. A. M.

CORROSION

1279. Organic chromates as additives for temporary petroleum-based corrosion inhibitors. (In Czech.) R. Bartonicek and L. Cerveny. *Chem. Prum.*, 1958, **8**, 622–7.—The effect of hydrocarbon soluble organic chromates as additives to increase the protective ability of such inhibitors was studied. Experiments showed that the degree of solubility of the additive in the inhibitor was the deciding factor for the inhibiting activity of chromates. Minimum solubility value was a concn of 2 g organic bound chromate in 1 kg of inhibitor. Empirical experiments with inhibitors made from esters of chromic acid with tertiary alcohols gave excellent results.

G. W. T.

1280. Anti-corrosion measure—insulated flange joints pre-assembled and tested. M. Buechler. *Pipe Line News*, May 1959, **31** (5), 67.—One of the best methods to minimize or eliminate galvanic corrosion in pipelines is the introduction of a dielectric material into the system, *i.e.* in the flanged joint. The joint is composed of a pair of flanges with the faces insulated from one another by a dielectric gasket, and with bolts insulated from the flanges by the same material. Micarta, Formica, or Bakelite are the usual insulating materials. Shop assembly of insulated flanges offers many advantages over field assembly, and these are described in the paper. M. F. M.

1281. Corrosion prevention of open box coolers. R. A. Lowe. *Petrol. Times*, 22.5.59, **63**, 399.—Open coil in box coolers are still extensively used in spite of disadvantages, including complete removal of pipework for maintenance, which latter involves dismantling, sand blasting, and welding up fitted sections. At the Fawley refinery of Esso Petroleum Co Ltd cathodic protection was installed, using an anode consisting essentially of a lead alloy extruded over a copper core. This has proved economical in operation; box no longer has to be stripped but merely hosed down. Maintenance costs are now a fraction of previous bills. G. A. C.

1282. Calcareous coatings—corrosion engineer's offshore ally. D. M. Taylor. *Pipe Line Ind.*, March 1959, **10** (3), 36–9.—Steel immersed in sea water is electrolytically coated with a calcareous deposit by impressed current. This deposit gives good corrosion protection and can displace rust and barnacles. Magnesium anodes of sufficient size to carry a total of 10 amp-hr/sq ft of bare steel are fitted at bare patches in addition to the normal protective anodes, and current is supplied at 50 mA/sq ft. A pipeline coating badly damaged after laying has been repaired in this way. G. B.

1283. How to design impressed current systems. Pt 1. J. C. Bell. *Pipe Line Ind.*, March 1959, **10** (3), 40–6.—The number and spacing of rectifier and ground bed units is determined by a balance between power cost and the cost of maintenance, etc. In general, the more units used, the lower the power consumption. In many cases, particularly with bare lines, the length of pipe protected by a given impressed current from one anode can be determined only by potential measurements at numerous points, but in other cases it can be calc approx from fewer measurements. Equations, graphs, and nomograms are given to assist in attenuation calculations.

G. B.

1284. Advance in rectifiers solve protection problems. T. R. Stilley. *Pipe Line Ind.*, March 1959, **10** (3), 51–5.—Stray currents can be prevented from interfering with cathodic protection and can sometimes be used to supply the protective current by the installation of half-wave rectifiers. Constant current units incorporating rectifiers offer a cheap control in variable conditions. The rating of silicon diode and selenium plate rectifiers is discussed. G. B.

1285. Corrosion studies in alkanolamine systems. J. D. Sudbury, O. L. Riggs, and J. F. Leterle. *Proc. Amer. Petrol. Inst.*, 1959, **38** (3), 51–8.—Lab studies are presented of an unusual corrosion process occurring in aerobic alkanolamine–brine systems. The corrosion process (designated filiform corrosion) was an oxygen concn cell growing in a highly directional manner. This growth was recorded as a time-lapse movie. Available oxygen corrosion inhibitors did not inhibit growth of this corrosion. An inhibitor was developed which successfully controlled filiform corrosion and general corrosion in lab diethanolamine (DEA) systems at temp up to 200° F. An evaluation of this inhibitor in two refinery Girbitol units was started, and preliminary results are reported. (Authors' abstract.)

1286. Solutions to corrosion problems in light hydrocarbon liquids plants. J. S. Connors and C. L. Seyer. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 39–50.—See abs. **2244**, 1958.

1287. Corrosion experience in catalytic reformers with naphtha pretreaters. E. B. Backensto and R. W. Manuel. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 31–8.—See abs. **2105**, 1958.

ENGINES AND AUTOMOTIVE EQUIPMENT

1288. Practical approaches to cold weather testing. C. C. Runyon. *SAE Paper No.* 305, 1959.—Paper discusses the difficulties of outdoor testing for engine performance, heaters, defrosters, fuel-induction systems, and other automotive components. These problems were overcome by cold room testing and practical procedures for simulating natural conditions in the lab. Necessary precautions and specialized equipment were treated with examples from the cold room lab. G. W. T.

1289. Evolution of the automobile internal combustion engine. M. Dangauthier. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1373–85.—Progress in automobile engines in Europe and the U.S.A. from 1933 to 1958 is surveyed. Graphs illustrate changes in power, torque, CR (with corresponding ON changes), bore/stroke ratio, connecting rod bearing load, and fuel consumption. W. A. M.

1290. Multi-fuel engines the order of the day: the VIGOM process. R. Vichnievsky. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1592–600.—Fuels of low cetane No in conventional CI engines give rise to long delays in combustion, followed by rapid pressure increase which may cause vibrating combustion. In the VIGOM process the delay is overcome by double injection of the fuel, using a special injection pump. The first charge is injected several degrees before the exhaust valve closes, and a roughly equal charge is injected at the end of the compression stroke at normal advance. Conventional fuel injection pumps can be modified by fitting a suitable camshaft. Results of experiments on Poyaud 2-cyl 2 PDI and 8-cyl 8VPYl, and diesel-air 2L engines, using gas oil and gasoline, with single and double injection, are tabulated. Double injection generally gives equal or slightly lower fuel consumption, slower pressure build-up, and slightly less noise. (*Cf* Abs. **958**, 1959.) W. A. M.

SAFETY PRECAUTIONS

1291. Safety-technical values of combustible gases and vapours. (In German.) P. Dittmar. *Erdöl u. Kohle*, 1958, **11**, 25–30.—Combustion and flammability limits of gases and vapours in mixtures with air are outlined. Types of ignition are discussed, also flame propagation in relation to fuel/air mixtures, with a supporting spherical shell diagram. Ignition sources primarily responsible for detonation and explosion are outlined. Two ignition limits exist—one each for higher and lower fuel concn—which enclose an ignition range, an important guide to flammability of a gas/air mixture. These may be determined in the illustrated apparatus. Determination and relative val of data for ignition temp by VDE and ASTM methods are discussed. 7 refs. R. T.

1292. Air pollution by diesel fumes. II. Sir Walter Fergusson Hannay. *Petrol. Times*, 22.5.59, **63**, 402.—The German Federal Government are considering a Clean Air Act, and is unlikely to repeat tragic omission to deal with diesel fumes made by British Government in its Clean Air Act, 1956, despite protests from both sides of the House.

It was considered that smoke from motor vehicles was adequately controlled by Road Traffic Act 1931, but no enforcement of these most necessary regulations occurs.

Investigations so far made, according to Dr Lent of Germany, show that fumes emitted form smog with SO_2, which is a great danger to sight and lungs. The combination of poisonous chemicals from fumes with soot and oil globules can be very serious; it has been shown that chronic bronchitis is a factor in lung cancer, and fog and smog are potent causes for this condition. Discussion showed that many leading authorities in the U.K. minimize and even ignore the increasing dangers caused by diesel fume pollution of air, which danger could be largely eliminated by fitting effective exhaust filters. G. A. C.

ECONOMICS AND MARKETING

1293. World petroleum statistics 1957. Anon. *Inst. Petrol. Rev.*, 1959, **13**, 156–61.—World production of crude petroleum reached 6440 million brl in 1957, an increase of 5·1% over the figure for 1956 according to statistics published by the U.S. Bureau of Mines. Crude petroleum imported into W Europe during 1957 totalled 757 million brl, a slight gain over 1956. *Ca* 80·5% of the crude shipped to the area went to the U.K., France, Italy, and the Netherlands. Exports of crude from the Middle East, exclusive of receipts by Aden and Bahrain, totalled 972 million brl in 1957, a slight gain over 1956. Within this total the greatest fluctuations compared with 1956 were registered by Iran (34% increase) and Iraq (31·8% decrease). Venezuela exported 759 million brl of crude, a 13·6% increase over 1956. In the sphere of refining, crude runs to stills amounted to 6295 million brl, whilst the output of major products came to 5182 million brl, compared with 5097 million in 1956.

The free world demand for major refined products in 1957

was 4753 million brl, compared with 4654 in 1956. Following percentage gains occurred in regional groups. N America and Caribbean, 0·5; S America, 5·5; W Europe, 0·6; Middle East, 11·1; Asia, 21·4; Africa, 10·6; and Oceania, 6·8.
A. D. S.

1294. Oil finding costs hit new peak. H. J. Struth. *Petrol. Engr*, Jan 1959, **31** (1), B24–30.—The continued upward spiral of oil finding costs in the U.S.A. is an indication of the hazards attending the search for new oil reserves. The average cost of finding a brl of oil within the last 21 years was only 57 cents, compared with today's cost of $1.33. Today's high costs must ultimately be compensated by higher oil prices and adequate depletion allowance. The economic position of U.S. oil producers is decidedly unfavourable, and definitely indicates that oil is undervalued in relationship with today's costs. Last year the gross quantity of reserves found per exploratory dollar dropped to only $\frac{5}{16}$ of a brl, whereas in the years 1936–38 discoveries averaged 8·9 brl per exploratory dollar.

The paper gives a number of charts and tables showing the economic position of U.S. oil producers, relative exploration costs and value of reserves discovered, economic statistics relating to wildcats, producing wells, drilling, and development of new fields.
M. F. M.

1295. Increased U.K. oil consumption in 1958. Anon. *Inst. Petrol. Rev.*, 1959, **13**, 200–1.—Consumption of petroleum products in the U.K., excluding foreign bunkers, rose to 31,065,629 tons, a 25·3% increase over the figure for 1957. This is a return to the trend of the increased demand for oil products, contrasting with a drop of 1·9% registered in 1957, which was adversely affected by the Suez crisis. Nevertheless, the 1958 total is also an increase of 23·2% over 1956, the last previous year of "normal" consumption. Details are presented in tabular form.

The largest increase in individual products was in the use of fuel oil, which, excluding refinery usage, showed a 52·7% rise. Its use for central heating and steam raising increased particularly rapidly.

Deliveries of gas/diesel oil were up by 27·6%, and again its use in central heating increased considerably. Motor spirit was 15·3% up on 1957, but only 4·7% above that for 1956. Use of derv fuel increased by 14·2%. Consumption of burning oil showed the notable increase of 41·4% over 1957. There was a decline in the use of vaporizing oil, the drop being 14·7% compared to 1957. Another declining demand was for aviation fuels, owing to the increasing use of jet propulsion.
A. D. S.

1296. The political economy of energy. Anon. *Petrol. Times*, 22.5.59, **63**, 395.—An outline is given of the three lectures recently given by Dr Tugendhat at the London School of Economics and Political Science. Current energy policy takes into account that British coal will remain basis of our economy, and need for its full exploitation is ever urgent. Nuclear power will eventually take over base load power stations, and industrial fuel oil is a complementary fuel.

Other factors are social and psychological effects of dependence on imports. Policies of France and the U.K. are similar, but a fuel policy based on free market economy is likely in time.

Suggestions for a convertibility requirement include complete freedom of purchase for all requirements in the cheapest market, energy production with minimum capital outlay and max return, and production of fuel and power by integrated undertakings.

Additional measures must secure fuel supply to offset any fall in U.K. production, and work on methods of increasing coal production at competitive prices may have to be intensified.
G. A. C.

1297. Large scale organization and change: a study in oil marketing. C. T. Brunner. *J. R. Soc. Arts*, 1959, **107**, 180–98.—The change in the marketing organization of Shell Mex and BP Ltd in the U.K. since the disbanding of the Petroleum Board is discussed. The main features are decentralization with a head office and fewer and larger divisions, branches, and depots and closer definition of each person's reponsibility. Products are handled in the greatest bulk possible. The sale of special products in small quantity and ancillary work, such as vehicle repair, are contracted out. Tied garages are a part of the company's policy.
G. B.

1298. Qatar: from poverty to opulence. Anon. *Petrol. Press Serv.*, 1958, **25**, 380–2.—Oil exports from Dukhan, the country's only field, began on the last day of 1949, and production has reached a rate of *ca* 8 million tons p.a. For 1957 it was 6·5 million tons, 12% increase over 1956. Concession for oil production over the whole shaikhdom and its three-mile territorial waters was assigned to Petroleum Development (Qatar) Ltd, later Qatar Petroleum Co, an associate of the Iraq Petroleum group, in 1935. Drilling began on an obvious anticline near the W coast, in the Dukhan hills, and at 1939 end the first well found oil of 36° API at 5500 ft, yielding *ca* 5000 bd. The wells were shut down during the war. Drilling began again late in 1947, and by 1949 20 miles of 12¾-inch pipeline and 53 miles of 14-inch had been laid across to Umm Said on the E coast, and exports began, reaching 3½ million tons in 1952. The field now has *ca* 50 wells and is producing from an average depth of 6500 ft. Reserves are estimated at *ca* 190 million tons. Exploration for new fields has been disappointing. The port of Umm Said has been developed and there is no limit to the length of ships which can be accommodated at the three submarine loading berths, but draught is limited to tidal conditions. Search for new oil is being continued by the Shell Co of Qatar after various failures offshore. In no country of the world can oil development have made a greater difference than in Qatar. Extreme poverty was rife, but in pursuance of the 50/50 agreement of 1952, the Ruler received £15·9 million in 1957. Half of the oil revenue is expended on local development and welfare, ¼ is invested as a reserve, the rest is absorbed by the Government and governing family. Doha has been rebuilt and a £3½ million hospital was opened in 1957. Qatar has revenue per head comparable with Kuwait.
R. T.

MISCELLANEOUS

1299. *Petroleum Refiner*'s 1959 maintenance cost survey. F. L. Evans. *Petrol. Refin.*, March 1959, **38** (3), 136.—Maintenance costs are one of the most elusive items in plant operation. A survey of all of the refineries and petrochemical plants has recently been made by the *Petroleum Refiner* with the idea of establishing a maintenance cost yardstick. In order that the same basis may be used for all plants, a definition of maintenance cost was established. This was "direct maintenance labour and material cost." A number of graphs are shown in the paper on which the average maintenance costs for the year 1958 are expressed as a percentage of the replacement cost of the plant. The figures quoted are; crude unit (atmospheric) 3·36%, crude unit (two-stage) 2·68%, cat cracker unit 2·28%, reforming (fixed-bed) 2·84%, alkylation unit (sulphuric acid) 2·72%, polymerization unit 3·10%, natural gasoline plants (absorption) 1·55%, natural gasoline plant (cycling) 1·58%, ammonia unit 2·41%, ammonium nitrate unit 6·85%, urea unit 4·25%, ethylene unit 2·85%,

polyethylene 3·78%, butadiene unit (butane) 1·98%, butadiene unit (butenes) 2·14%, sulphur recovery unit 2·78%.
M. F. M.

1300. Refining hall of fame. Anon. *Petrol. Refin.*, Jan 1959, **38** (1), 188–90.—This article is a very short biography of eight men (Kier, Dubbs, Kalichevsky, Houdry, Burton, Brown, Egloff, and Ipatieff) who have rendered great service to the petroleum industry, and thus have been elected to the " Refining Hall of Fame " by the journal. M. F. M.

1301. The refining story. C. A. Umbach, Jr and H. L. Hoffman. *Petrol. Refin.*, Jan 1959, **38** (1), 146–64.—This is a most interesting and illuminating article which traces the history of refining from centuries before Colonel Drake's first oil well drilled at Titusville in 1859 up to the present date. The article starts with a description of Kier's little (one brl capacity) refinery and the troubles he encountered in producing what he called " carbon oil." It then outlines Benjamin Silliman's early work on rock oil or petroleum in 1855. The dramatic growth and development of oil refining techniques are then traced through the past 100 years, and a number of historic photographs are appended which are of much interest. The role of oil in world wars is discussed and future trends are briefly mentioned. M. F. M.

1302. Refining flexibility and the problems of seasonal demand. H. Ferguson. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 18–20.—Petroleum refiners have been able to meet seasonal demand variations by varying crude oil runs, using seasonal storage, and varying the yields of products from crude oil. Although the refiner has the flexibility to meet expected variations, these variations must be met as economically as possible, The use of existing seasonal storage capacity, which can be maximized by careful planning in advance of the anticipated changes in demand, is certainly the most practical method. The individual refiner must also consider the overall supply–demand situation as reflected by industry inventories in making decisions regarding crude oil runs, yields, and inventory strategy to put his operations on an optimum basis.
(Author's abstract.)

1303. World energy and world oil. N. B. Guyol. *Petrol. Refin.*, Jan 1959, **38** (1), 192.—Crude oil is now the world's most valuable mineral product worth *ca* $20 billion p.a. with gross annual industry sales of *ca* $60 billion. This is approx 6% of the world's expenditure for all purposes. Barring any war or depression, world energy requirements will grow *ca* 4% p.a., and it is estimated that world oil consumption should be *ca* 55 million bd by 1984. The estimated percentages of world requirement of commercial energy sources in 1984 are as follows: petroleum products 37%, natural gas 12%, coal and lignite 49%, and water 2%. The average annual rate of increase in world energy requirements has been 4·5% yearly, and it is reasonable to suppose that, barring war or depression, this rate of growth will be maintained in the next 25 years.
M. F. M.

1304. Catalytic oxidation of automobile exhaust gases—an evaluation of the Houdry catalyst. G. J. Nebel and R. W. Bishop. *SAE Paper No. 29R*, 1959.—Oxidn is technically feasible when using commercial leaded gasoline, and hydrocarbon emission can be substantially reduced by this process. Overall efficiency or percentage reduction depends on many factors, but with this cat a value of 75% (after warm-up) seems reasonable. CO is oxidized to about the same degree. By combining the cat to remove hydrocarbons and CO and the special carburettor to remove oxides of nitrogen, the following reductions (after warm-up) seem reasonable: hydrocarbons, 90%; CO, 75%; and oxides of nitrogen, 90%. The cat is resistant to poisoning by TEL combustion products, and its useful life is estimated to be *ca* 12,000 miles. G. W. T.

1305. The development of a catalytic converter for the oxidation of exhaust hydrocarbons. R. T. Van Derveer and J. M. Chandler. *SAE Paper No. 29S*, 1959.—Data are presented on the efficiency of V_2O_5 cat in the Ford cat converter system. Overall operating efficiencies of 60–73% can be expected. Tests with the converter in a smog chamber achieved average hydrocarbon conversion efficiencies of 88 and 91% respectively for idle and deceleration, and efficiencies of 68 and 74% respectively were achieved for acceleration and cruise. With a converter slightly larger than a standard muffler, cat durability of over 10,000 miles has been attained. As a low-temp cat is used, expensive stainless steel is not required in the construction of the converter. G. W. T.

1306. In-plant pollution control in practice. 1. Petroleum industry. S. O. Brady. *Chem. Engng Progr.*, 1959, **55**, 45–8.—Paper discusses the problem of waste disposal in a refinery from the in-plant control approach as compared with the total treatment. This in-plant approach is to use preventive measures to reduce the amount, or strength, of polluting wastes, or to eliminate the production of certain wastes. The measures described in Vol 3 of API Manual on Disposal of Refinery Wastes were used as a basis for discussing the effectiveness of this control for solving waste disposal problems.
G. W. T.

1307. Air pollution abatement: a survey of current practices and costs. W. L. Faith. *Chem. Engng Progr.*, 1959, **55**, 38–43.—This report began as a survey of the chemical process industries to determine current practices in air pollution abatement, and the nature and cost of installations made since Jan 1956. Replies were received from 95 of the 160 companies circularized. The report deals chiefly with the control of emissions from processing; problems of smoke, fly ash, and sulphur dioxide from power plants are omitted. Much of the information was submitted on a confidential basis, so company names are mentioned only where the information has been published previously. G. W. T.

1308. Programme of great works. (In Russian.) Anon. *Khim. Tekh. Topliv Masel*, Dec 1958, (12), 1–3.—In accordance with the Seven-Year Plan for 1959–65, U.S.S.R. primary petroleum refining capacity will be increased 2·1–2·2, cat cracking 4·3, cat reforming 16–18, and lub oil manufacture 2 times. Crude oil production in 1965 is expected to reach 230–240 million tons p.a., with an annual increase of 16·7–18·1 million tons. The 1965 quota for natural gas production is 150 billion cu m. Chemical production is expected to triple, synthetic fibres will increase 12–14 times, and plastics 6–7 times. Capital investment in the petroleum and gas industry for 1959–65 will be 170–173 billion roubles, or 2·3–2·4 times greater than in the previous Seven-Year Plan. Total capital investment in the petroleum, gas, and chemical industries will be more than 14% of the capital investment in the entire national economy. Approx 43% of the increase in refining capacity will be achieved by reconstruction, expansion, and intensification of existing facilities. G. W. T.

1309. Review of Middle East oil. Pt I. Developments in the Middle East 1948–59. S. H. Longrigg. *Petrol. Times*, 10.4.59, **63**, 221.—An excellent general survey of the activities and settings of the petroleum industry in the Middle East as at 1958–59 is given, designed to a certain extent as a modernized " Review of Middle East Oil " published by *Petrol. Times*, June 1948.

There are 11 chapters in the issue, which deal with the region, view of the industry, the less fortunate countries, the greater producers, companies and concessions, workers and politics, geology, geophysics, drilling, production, transportation, refining, and exporting. G. A. C.

BOOK REVIEWS

Recent Advances in Petroleum Chemistry and Refining. Vol. 2. Ed. Kenneth A. Kobe and John J. McKetta, Jr. New York, London: Interscience Publishers, 1959. Pp. xviii + 634. 109*s*.

The first volume of the series " Advances in Petroleum Chemistry and Refining " was reviewed in this journal in December 1958. This book is the second volume in the series, which at approximately annual intervals will present progress reports on chosen subjects within the field of petroleum chemistry and refining. Each volume contains chapters in five groups:

Group I	Economics and Future Trends
Group II	Unit Operations and Design
Group III	Refining Processes
Group IV	Petrochemicals
Group V	Mechanical Equipment

This volume commences with a survey of the availability and economics of raw materials for the petroleum chemical industry and, with the example of the development of the manufacture of butadiene from 1942 onwards, illustrates the importance of intensive economic analysis of alternative routes to a chosen product. Production and consumption figures for the U.S.A. for a number of the more important chemicals from petroleum are given up to 1956. The second chapter in Group I, Economics and Future Trends, deals with Trends in Lubricants. This is an extremely comprehensive review of theoretical and practical developments in lubrication in recent years, and 345 references are given to literature up to mid-1957. A detailed comparison is made between synthetic and natural lubricants, and the account of the influence and efficacy of the growing number of additives in current use in this field will be welcomed by many technologists.

Group II, Unit Operations and Design, has chapters on Pebble Heaters and Radiation Techniques. The pebble heater is not widely used for cracking petroleum products in Europe, and although the authors have clearly stated the operating difficulties and their methods of overcoming them, potential mechanical troubles are still likely to be a deterrent to their use. The section on Radiation Techniques is largely devoted to analytical methods using radio-isotopes and the measurement of glow and mixing patterns and gives a very readable account of the work in this field to date.

The refining processes chosen for inclusion in this volume are Sulphuric Acid Alkylation of Paraffins, Coking Petroleum Residues, and Radiation Processing. The section on alkylation treats the latest design features and practical and optimum operating conditions for commercial units, the theoretical aspects having been dealt with in Vol 1. A wealth of practical detail is given both in this chapter and in the following one on Coking Petroleum Residues, which will make them invaluable to workers in the field. At the same time the treatment is such that the comparative newcomer, the technologist who has worked outside these particular subjects, can rapidly understand the important points. Radiation Processing is now becoming of practical interest to the refiner for speciality products, and its potential interest for treatment of large polymer molecules on a large scale earns it its early place in this series.

The Manufacture of Synthetic Detergents from Petroleum and the Commercial Production of Hydrazine comprise Group IV, while Group V contains an account of Mechanical Aspects of the Houdriflow Catalytic Cracking Process. It is hoped that this excellent account will be followed by a similar one on the more popular fluid process.

Once again the presentation of the book is excellent and the editing has been carefully carried out. It is sad to think that Dr Kenneth Kobe, who died late last year, has not lived to see this series have the success which it undoubtedly deserves. A. J. B.

Process Dynamics. D. P. Campbell. New York: John Wiley and Sons; London: Chapman and Hall, 1958. Pp. xix + 316. 84*s*.

The author, a universally recognized authority on servomechanisms, has written this book after directing his knowledge for some twelve years to the application of feedback control theory to process control. In the preface criticism is made of much of the work being done in the process control field, which, because of its historical background, has become little more than an empirical art. Plant designers are also criticized for conceiving plants along steady-state lines instead of treating them as dynamic working systems, which they are when subject to any control system.

After such criticism, it is not surprising that the character of the book differs from that of the standard books on process control. It deals with the physical behaviour of the common unit processes encountered in modern plants, and derives from basic physics the mathematical equations governing the processes. A common approach is used throughout in attempting to state the dynamic equations of the physical processes in the form of transfer functions, with which the control engineer is familiar, and by which their effects on the performance of a control system may be studied.

There are chapters devoted to the storage and handling of liquids, solids, and gases; liquid flow; extrusion, drawing, rolling, and tension control; thermal processes; mass transfer; and chemical processes.

The book is not intended for beginners and assumes that the reader is familiar with the principles of automatic feedback control. It must be one of the first, if not the first, text-books to have been written on process dynamics. It will without doubt serve to stimulate research work into more complex processes, and will help to direct the approach to process control along lines whereby it can claim to be a " science." H. J. H.

Proceedings of the International Symposium on Macromolecular Chemistry. London: Pergamon Press; Czechoslovak Academy of Sciences, Czechoslovak Chemical Society, 1959. Pp. 306. 35*s*.

The symposium, which took place in Prague, September 1957, was held under the auspices of the International Union of Pure and Applied Chemistry (IUPAC). The proceedings have been issued in the form of a joint publication as a supplement to *Tetrahedron* (No. 2) and a special issue of the *Collection of Czechoslovak Chemical Communications* (Volume 22, 1957).

To review a collection of papers presented at a symposium dealing with the chemistry of high polymers and published in English, French, German, and Russian is not easy, and there is little more a reviewer can do beyond commenting generally. In addition to the opening speeches, the two main lectures given by Professor P. Doty, of Harvard University, Cambridge, Mass, on " Biological Polymers " and Professor H. Mark, Polytechnic Institute of Brooklyn, New York, on " Progress in the Field of High Polymers " are given in full. The papers are divided into two sections —" Physics and Physical Chemistry of Macromolecules " (5 papers) and " Polyreactions " (13 papers). The quality

of these is high, most of the authors being well known in the field of polymer chemistry. Even for those not directly associated with this field they make interesting reading.

The volume is well produced, printing is extremely good, chemical and mathematical formulæ, figures, and so on are well laid out. There are relatively few errata.

Both the editor and the publishers are to be congratulated on the general excellence of this volume, which is a very reasonable and worthwhile buy. S. F. B.

Handbuch der Stratigraphischen Geologie. Bd. III. Tertiär 1.Teil. Grundzgue Regionaler Stratigraphie. Prof. Dr Adolf Papp. Stuttgart: Ferdinand Enke, 1959. Pp. xii + 411. DM 88.

This handbook has been compiled by Dr Papp with the assistance of Dr A. Tollmann (Africa), Dr K. Turnovsky (Asia Minor), Dr M. F. Glaessner (Indo-Pacific region), and Dr W. Klaus (Palynology). It is a compilation which includes much information that has been published in the last decade or two, and is well illustrated by diagrams, charts, and tables taken from many sources; as in the case of many compilations, however, there are some discrepancies arising from the different views taken by different authors, there having been no attempt to decide the issues involved. Furthermore, information from some fairly modern publications has been accepted without question, whereas it would seem to have been better to have followed the sound and well established views of such experienced stratigraphers as Émil Haug.

The main emphasis of the book is concerned with the Tertiaries of Europe, well over half the number of pages being concerned with this region. The subject is well covered, and the author gives a mass of useful information, but there are a number of contentious matters which have not been satisfactorily resolved, and several cases of incorrect information being given owing to lack of co-ordination.

Following the opinion of some micropalæontologists, the Palæocene is treated separately from the Eocene, although from the point of view of general palæontological relationships it forms the lowest subdivision of the Eocene. The statement (p. 80) that the Palæocene is equivalent to the Danian is not in accord with the opinion of the majority of workers who have made a careful study of these faunas. The record that *Globotruncana stuarti* and *Miscellanea* occur together in the Danian (p. 80) is also incorrect and is evidently based upon miscorrelation; the former does not survive the Mæstrichtian, and the latter is restricted to the Palæocene. Records of *Calcarina* from the Upper Cretaceous (p. 80) evidently refer to *Siderolites*. On the table on p. 325 the Vincentown and Hornerstown formations have been shown as mainly equivalent to the Wilcox, whereas Loeblich and Tappan have shown them to be Upper Midway.

On the table on p. 139 the Saratow formation (s.s.) is shown as Palæocene although it contains the Lower Eocene *Nummulites spileccensis* and *N. mefferti*; the formation (s.s.) is evidently of Lower Eocene age, which is quite in accord with recent records of *Globorotalia velascoensis* from the lower part of the Lower Eocene (in West Pakistan) as well as in the Palæocene. On p. 129 *Assilina granulosa* is recorded from the Upper Lutetian; there has in the past been much confusion between this species and *A. exponens*, and the evidence suggests that *A. granulosa* is restricted to the Lower Eocene and *A. exponens* to the Middle Eocene. With regard to the East African Palæogene (p. 272), *Nummulites hormoensis* is Upper (not Middle) Eocene, the species *tipperi* belongs to the genus *Lockhartia* (not *Dictyoconoides*), and *Dictyoconoides newboldi* has been shown to be a juvenile of *Rotalia trochidiformis*. In Egypt the Upper Mokattam is, evidently following Cuvillier and Schaub, shown as of Wemmelian and Ledian age; however, the Upper Mokattam contains both *Nummulites beaumonti* and *Orbitolites complanatus*, neither of which (on abundant evidence) survived the lower part of the Auversion (Ledian), but, as far as we know, no species characteristic of the Wemmelian. On p. 27 *Clavulinoides szaboi* is recorded from the Oligocene of Hungary; while the species may occur in beds of this age, its type occurrence in Hungary is in the Wemmelian (Upper Eocene), in association with *Discocyclina* and *Pellatispira*. On the table on p. 35 it is not made clear that *Pellatispira* and *Biplanispira* are restricted to the Upper Eocene.

The Aquitanian is, in our view, incorrectly placed in the Oligocene, since not only do the faunas from Aquitaine undoubtedly belong to the Neogene evolutional surge, but the beds themselves constitute the first marine transgression of the Tethyan Miocene; a further inference from the table on p. 17 is that *Nummulites* occurs in the Aquitanian, whereas it is extremely doubtful if any true *Nummulites* survived the Rupelian. The suggested appearance of *Orbulina* at the Tortonian/Helvetian boundary (pp. 15, 19, 32, 33, 346) is also incorrect, since it is known to have appeared near the top of the Aquitanian, as is correctly stated on p. 299 and has been shown by LeRoy in 1944. *Austrotrillina howchini* is not an Eocene species as stated on p. 27; it is correctly recorded on p. 308 as being Lower Miocene only (Aquitanian and Burdigalian). The succession of *Miogypsina* species in the Bordeaux area (p. 20) is probably correct, but in correlating with the Turin area no allowance is made for varying facies conditions and for the fact that species do have ranges, and the dating of the Turin species is open to question; some reference might have been made to the works of Ruscelli and Giannotti. *M. burdigalensis* (actually a *Miolepidocyclina*) has its type occurrence in the Aquitanian, and is, as far as we know, restricted to beds of Aquitanian (not Burdigalian) age. Furthermore, there has been no attempt to redate the American beds (called Oligocene) which contain the same succession of Miocene species of Miogypsinids. On p. 46, *M. thalmanni* and *M. basraensis* are quoted as being of Oligocene (Chattian) age, whereas the genus (s.s.) is restricted to the lower half of the Miocene. The name *M. irregularis* is, incidentally, invalid, the species name being a homonym, and it should evidently be replaced by *M. globulina*. The record of *M.* cf. *formosensis* (actually a *Miogypsinoides*), from the Chattian of the Balkans (p. 134), is likely to be misleading, since the species was described from the Burdigalian of Japan. On p. 299, the ranges of foraminifera in Sumatra are also liable to be misleading, since *Eulepidina* and *Spiroclypeus* do not survive the Aquitanian. On the table on p. 35, *Eulepidina* might well have been included. On p. 290, *Neoalveolina melo curdica* is recorded as being of Vindobonian age, but numerous occurrences familiar to us do not confirm this view, but indicate that it is of Burdigalian age.

With further reference to the Tertiary successions in America, we would point out that current opinion agrees with the Miocene extending at least as low as the Zone of *Globigerina ciperoensis ciperoensis*. The table on p. 339 does not seem to have been taken accurately from Kugler. The table on p. 351 does not seem to include the conclusions of Durham *et al* concerning the revision of the Peruvian succession, especially with regard to the dating of the *Hannatoma* fauna.

In spite of the above comments, we would repeat that the Handbook is a very useful work of reference, with a good bibliography and a good index. It is printed well on good quality paper, and there are very few misprints (*e.g.* Saccamminidae, Ophthalmidiidae—p. 15; *Nuculana*—p.

314; *Laffitteina*—p. 36). The generic name *Corbis* (p. 135) has been replaced by *Fimbria*.

It seems strange that no more recent evidence than that of Lyell in 1832 is available concerning the percentages of Recent species in the Eocene, Miocene, and Pliocene (p. 4); these figures must surely be out of date, and do not even refer to the Oligocene.

F. E. E.
F. T. B.
W. H. B.

Ozeane Salzlagerstätten. H. Borchert. Berlin: Gebrüder Borntraeger, 1959. Pp. viii + 237. DM 48.

This book is an excellent successor to Professor Borchert's earlier works on salt deposits. It presents a masterly review of the complex history of marine evaporites, from their initial deposition to their later reconstruction by geothermal metasomatism, leaching by groundwaters, and other processes.

The first part of the book is devoted to depositional factors. A discussion of the general climatic, topographic, and tectonic conditions, with especial reference to the Zechstein evaporites, is followed by sections on the separation of salts from sea water under static isothermal conditions, and under "dynamic polythermal" conditions where temperatures vary in different parts of the depositional area. These involve the calcium salts and the relevant part of the system Na–K–Mg–Cl–SO_4–H_2O. Metastable phenomena are considered.

The following 73 pages deal with post-consolidation metasomatic changes, including the various stages of metasomatism of important salt parageneses by solutions resulting from melting with rise of temperature and pressure on burial, migrating from upper layers to lower ones and vice versa, and by solutions produced by groundwater leaching and from juvenile waters. The evidence for metasomatism in salt deposits is discussed in detail, and includes the occurrence of mineral phases and parageneses unstable under conditions of primary deposition, textural evidence (pseudomorphs, etc.), veins and impregnations, blue halite, and certain types of facies change. The processes are discussed in relation to experimental work, and the principal changes in the Zechstein evaporites are given.

The rest of the book includes comparisons of oceanic and non-oceanic deposits; sections dealing with the evaporites of the Rhine graben and some other deposits; the association of salt with oil; and a discussion of salt tectonics and the mechanical properties of salts. There is a large and useful bibliography (40 pp.).

The book would be improved by the addition of more text figures (*e.g.*, maps showing facies changes in the Zechstein), but this is the only slight qualification in my admiration for a work which contains a very large amount of information, and deals with a highly complex subject in a way which makes it essential to all workers interested in evaporites and in metasomatic processes.

F. H. S.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1310. Origin of petroleum. W. G. Meinschein. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 925–43.—Sediments and crude oils contain the same types of hydrocarbons. This analogy indicates that petroleum is derived from sedimentary organic matter. The close resemblances of hydrocarbons in sediments and crude oils to plant and animal products show that most of these hydrocarbons are obtained either directly from the remains of living things or are minor modifications of living matter. Although many sediment and petroleum hydrocarbons are of the same type and are derived from a common source, the distributions of these cpds in petroleum differ from their distributions in sediments. Therefore, the conversion or accumulation of sedimentary organic matter to form petroleum must be done selectively. An explanation is presented of how water serving as the accumulating agent can produce the changes in distribution that are observed between sedimentary organic matter and petroleum.

E. N. T.
R

1311. Mode of use of organic microfossils for stratigraphic purposes in oilfield problems. B. de Jekhowsky. *Rev. Inst. franç. Pétrole*, 1958, **13** (10), 1391–418.—The organic microfossils are chitinous, cutinous, or cellulosic, and survive palynologic preparation techniques. They include pollens, spores, hystrichospheres, peridineans, and chitinozoa; the size range is 10–500 μ; some are as old as Cambrian. They occur in terrestrial, brackish, and marine deposits, and not only in typical organic deposits but also in clays, marls, and silts, and in other rock types less commonly. Their vertical range is often considerable, and in many cases varies geographically. Their associations from a quantitative angle vary sufficiently markedly and synchronously to be suitable for zoning and correlation. Sometimes they are available when classic micro- and macro-fossils are absent.

Sampling, analysis, the interpretation and precision of the results, and other features are discussed, together with numerous illustrations. G. D. H.

1312. Is there oil on the East Coast? F. J. Gardner. *Oil Gas J.*, 8.6.59, **57** (24), 231.—The oil and gas potential of the Atlantic Coastal Plain of the U.S.A. has been estimated at 7·7 billion brl of oil and 46·2 trillion cu ft of gas. Most of this is said to underlie the untested continental shelf, and only 200 onshore wildcats have been drilled over the entire area, which is *ca* 1100 miles long and 100–200 miles wide. Although no geophysical exploration for oil has been carried out, regional geophysical studies have revealed a ridge and flanking troughs near the outer edge of the shelf. C. A. F.

1313. East Texas prospect sputters ... and dies. F. J. Gardner. *Oil Gas J.*, 25.5.59, **57** (22), 261.—Attempts to obtain commercial production from the Woodbine sand on the Grand Saline salt dome in E Texas have been unsuccessful. Heavy black tar was recovered from *ca* 3500 ft. There are 18 piercement salt domes in the E Texas basin, and since 1956 there have been intensive efforts to obtain production from them. Hainseville and Bethel domes have already yielded oil, and prospects are good. Most of the domes have overhang, and successful drilling seems to depend on accurate interpretation of the form of the overhang and its effect on trapping. C. A. F.

1314. Permian Basin east shelf has variety of prospects. F. B. Conselman. *World Oil*, June 1959, **148** (7), 124.—The E Shelf of the W Texas Permian Basin has been exploited for many years, and there are many prospective reservoirs from shallow depths down to *ca* 8000 ft. Drilling is inexpensive and leases are favourable. The general geology of the fields is outlined, a notable feature being the abundance of stratigraphic traps. The most important of these are in the Permian and Pennsylvanian. Structures can be effectively mapped by core drill and surface mapping, using a variety of markers in these formations. Other useful exploratory methods are seismic and gravity exploration, subsurface geology, and photogeology. Detailed reflection shooting may be necessary for exploring deep anomalies. Stratum contour maps of some typical fields are given. C. A. F.

1315. Geologic case history of Slocum dome, Anderson County, Texas. J. L. Read, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 958–73.—The Slocum dome is a deep-seated interior salt dome in NE Texas. It furnishes a recent example of a "condemned prospect" rediscovered. Dense well control and reliable stratigraphic correlation allow a subsurface geologic case history that tells a story continuously repeated in the older oil-producing provinces.

Oil production was established in the Slocum area in 1935 from Woodbine and sub-Clarksville sands of Upper Cretaceous age. The initial production was located on the NW flank of the dome and was depleted by 1938. Significant production from the same formations on the SE flank was discovered in 1956, and active development has resulted in 15 new reservoirs. 90% of the cumulative production of nearly 2 million brl through 1957 is credited to the new reservoirs.

The dome is characterized by an elliptical outline and a central graben located transverse to the elongate axis. Radial faulting and stratigraphic variation combine to form several different types of oil and gas traps on the flanks of the dome. Cross-sections and isopachous maps reveal sand truncation during structural growth and the changing effect of domal growth on the area of its influence.

The geologic history of this dome has economic applications in NE Texas and in areas of similar geology. Evidence furnished concerning the area condemned by a single dry hole probably applies in every oil province. E. N. T.

1316. Continental slope off Southwest Florida. G. F. Jordan and H. B. Stewart, Jr. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 974–91.—Recent surveys of the W Florida continental slope made by the U.S. Coast and Geodetic Survey show for the first time the detailed topography of the S part of this area. A marked change in topography at 27° N latitude separates the N from the S part of the slope and is related to N-to-S changes from clastic to non-clastic underlying bedrock and from thick to thin or non-existent overburden of unconsolidated sediments.

A drowned barrier spit and lagoon unchanged by subsequent erosion or deposition were revealed at 75–100 fathoms. These features are described and discussed along with numerous long breaks in slope, embayments, and offsets in the steep lower slope, reef patches, dome-like structures, and spur-shaped ridges. E. N. T.

1317. Geology of Avery Island salt dome, Iberia Parish, Louisiana. F. W. Bates *et al. Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 944–57.—The present study reports the findings since the discovery of oil in 1942. The history of salt-mine operations is reviewed, present mining practices explained briefly, and the configuration of the salt mass as it is now known is described. Oil sands have been found ranging in depth from 4500 to 15,600 ft; 16,456 ft is the greatest depth to date drilled. The bulk of the proved reserves ranges from *ca* 8500 to 9500 ft in depth, and is located on the SW flank. Present drilling is mainly to define new deep reserves on the E flank, or explore for new reserves on the SE flank. Accumulative production totals 34 million brl of oil with minor vol of gas as of 1 May 1958. The total proved reserve is probably *ca* half depleted, with good possibilities for new reserves being discovered on untested or deeper flanks.

The structure of the drilled flanks has been found to be a complex of radial faults, salt overhang, and steeply dipping sediments with updip terminations against the shallow piercement-type salt mass. The age of formations penetrated ranges from Recent to the Discorbis zone of the middle Miocene. E. N. T.

1318. Bois d'Arc—key to Hunton oil? M. L. Oxley. *Oil Gas J.*, 11.5.59, **57** (20), 162.—Two recent finds of Siluro-Devonian Hunton oil in the NW Oklahoma area of the Anadarko Basin have been the first commercial Hunton discoveries in the basin. The Hunton has hitherto been largely overlooked as a potential reservoir formation, possibly due to lack of appreciation of the nature of the traps. The Hunton group includes the Bois d'Arc limestone, which seems to be the best target. A prime objective should be the definition of its truncated edge. It is a dense to finely crystalline limestone averaging 20–25 ft in thickness when completely developed. Favourable stratigraphic and structural conditions for accumulations exist. Secondary porosity zones have been observed in areas of weakness. C. A. F.

1319. Southern Utah . . . green field for wildcatters? E. B. Heylmun. *Oil Gas J.*, 25.5.59, **57** (22), 262.—Oil prospects of the Greater Virgin region between the Hurricane fault and Zion National Park in Utah are outlined. The area covers *ca* 350 sq miles and contains the old Virgin field, first drilled in 1907. Only a few deep tests have been drilled in the area, and the petroliferous Permian Kaibab limestone has not been fully exploited. Anticlinal fold trends are known from surface mapping, and these have generally low relief. Many of the structures have not been drilled, and there are possibilities for shallow structural accumulations and stratigraphic trapping. Development has been hampered by transport problems, the nearest rail and pipeline facilities being over 50 miles away. C. A. F.

1320. What are the prospects in Washington State? F. H. Wurden. *World Oil*, July 1959, **149** (1), 94.—Although ten wells drilled during the past ten years on the Ocean City anticline on the Pacific coast of Washington have had good oil and gas shows, commercial production has not yet been developed, but the area remains the best prospect in the state. Operations have been hampered by engineering problems and inadequate subsurface data. Miocene and Eocene marine beds are thought to occur down to 20,000 ft or more. The geology of the area is described: the structure is an anticline trending NW–SE, transversely faulted along the NW flank where the fold extends offshore. Total closure probably exceeds 400 ft. The best shows have occurred in the upper part of the Miocene Blakeley, a 6000-ft section of sandstone, shale, and conglomerate. C. A. F.

1321. Middle Devonian sedimentation and oil possibilities, Central Saskatchewan, Canada. R. W. Edie. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1026–57.—The stratigraphic interval discussed in this paper includes the Middle Devonian Elk Point group and Dawson Bay formation as defined by Baillie (1953). Detailed lithologic studies of the Elk Point strata suggest the presence of huge atoll-like reefs that pass laterally into, and are overlain by, salt. Thus far, no commercial fields have been discovered in these reefs, but with the very limited exploratory drilling to date they should be considered among the most prospective units for petroleum accumulation in Saskatchewan. In this paper an attempt is made to analyse limited subsurface facies and structural data and to point out areas of potential oil accumulation. E. N. T.

1322. Structure and accumulation of hydrocarbons in southern foothills, Alberta, Canada. F. G. Fox. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 992–1025.—The southern foothills of Alberta are composed of much compressed, imbricately faulted Palæozoic and Mesozoic rocks in an elongate belt between the Great Plains and the Rocky Mountains. Within the belt structural shortening has evidently been achieved mainly by thrust faulting, accompanied by the development of drag folds, most of which are not large. The major thrust faults lie in well-defined sliding zones, and they generally transect the bedding at relatively low angles. This is true for supposedly competent as well as incompetent beds, although there is apparently some refraction of fault planes between beds of differing competence. At and near the surface the faults commonly dip steeply, but this is a result of rotation and is not indicative of the dips the faults had when formed.

Structures that originated as folds and were later faulted may not exist. Turner Valley anticline, which is commonly regarded as a faulted fold developed from a protofold, might be an exception, but the evidence is by no means conclusive.

In this area oil and gas have been found in Cretaceous, Mississippian, and Devonian rocks. The reservoirs tapped to date are associated with thrust faults, and it appears that, with the possible but unproved exception of the Turner Valley pool, all the traps are fault traps. Migration of hydrocarbons might have started very early, but was not completed before the close of the Laramide revolution. There is no reason to suppose that all hydrocarbons migrated at once, or in any one direction, or that the process of migration was uninterrupted. E. N. T.

1323. Geology and petroleum expectation of the Chilean longitudinal valley. (In German.) H. Illies. *Erdöl u. Kohle*, 1958, **11**, 145–8.—Geology of the Chilean longitudinal valley is discussed with supporting maps and a schematic representation of the geological development between Valparaiso and the Canal de Chacao. Only the S part of the longitudinal valley has petroleum-geological interest, on whose E edge some small petroleum escapes on the Rio Petrohue are known. Whilst the drilling campaign along both sides of the Canal de Chacao from 1909 to 1913 was fruitless, further drilling produced gas outbreaks which can be attributed to pierced coal seams. Strong development on the fresh water molasse, of the Eocene, is bituminous in places and is considered as mother rock. Corresponding strata in the Lonquimay basin are developed as pronounced oil shales with oil cont 80 l/ton. The discordant unconformity of the Oligocene bentonite clays on weakly faulted or obliquely placed Eocene presents the appearance of structures favourable for petroleum accumulation. In the comparable Pacific edge zones of Peru and Ecuador, also in the inner Andean troughs of Colombia, under quite similar geological assumptions considerable deposit formations have arisen. In spite of favourable moments, it must be emphasized that only special exploration works in the region covered by a morain scree can bring further clarification. No further prognosis can be expected from the surface mapping. R. T.

1324. Exploration in Philippines progressing. C. E. Workman. *World Oil*, June 1959, **148** (7), 154.—Exploration is increasing in the Philippines, where oil shows have been found in several wells. Most of the drilling has been carried out in the Cagayan Basin of N Luzon. Seven Tertiary basins with thick marine sections have been mapped, and surface shows occur throughout the archipelago. The Cagayan Basin covers some 5500 sq miles and contains up to *ca* 20,000 ft of marine beds with structural and stratigraphic complexities. Photogeological and geophysical work have been carried out in the basin, together with surface mapping. Gas, proved non-commercial, was found in Ipil 1, *ca* 200 miles N of Manila, in 1958 in Miocene limestone at *ca* 4350 ft. Further development in the area may provide exploitable gas. C. A. F.

1325. The search for oil. Anon. *Chem. Engng. min. Rev.*, May 1959, **51** (8), 38–45.—The present state of the search for oil in Australia is reviewed. A brief account is given of the participation of foreign companies, which have invested a total of £20 million in four years. The activities of each company in all the mainland states and Australian territories are outlined. G. B.

1326. Surface evidence promises oil in Western Switzerland. R. F. Schwab. *World Oil*, May 1959, **148** (6), 198.—The Molasse Basin and Jura Mountains in W Switzerland have abundant surface shows of oil, gas, and asphalt, and the area has potentialities for commercial oil. The shows are tabulated by age, most of them occurring in Oligocene and Cretaceous rocks in anticlines. Some shows are found in synclines and fault zones. Four of the main shows are briefly described, and the broad lithology of the Tertiary to Trias sequence is outlined. No properly located wells have yet been drilled in Switzerland, but there is increasing interest in the oil possibilities of the country. C. A. F.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

1327. New tools for the geophysicist. Anon. *World Petrol.*, March 1959, **30** (3), 78.—Increased geophysical exploration in recent years has created equipment problems, particularly in remote and difficult terrain. Critical factors are equipment bulk and weight, and manufacturers are now adopting miniaturizing techniques. The most important is the use of transistors and silicon diodes, and rectifiers in field recording equipment; a 24-channel seismograph can now be packed in one case weighing less than 60 lb. The use of semi-conductors in place of vacuum tubes has reduced power requirements, and the trend towards lighter loads has enabled helicopters to be used for reconnaissance.

Other developments noted include the use of ammonium nitrate prills as a blasting agent, which has reduced explosive costs by 50%; and Siran, a device which simulates a seismic reflection trace from geological and geophysical data.

C. A. F.

1328. Helicopters move all gear, men in seismic survey. Anon. *World Oil*, June 1959, **148** (7), 146.—An experimental detailed seismic survey has been carried out in a marsh area of the Mississippi Delta, the entire operation being carried out by helicopter transport in order to investigate the feasibility of using this method in inaccessible areas where marsh buggies are excluded. It is concluded that, although more widespread use of helicopters is probable under these conditions, much depends on the type of drilling rig to be used; mounting the drill as an integral part of the helicopter is being considered. Lighter and more portable recording equipment is also necessary. C. A. F.

1329. Surface electric records can tell you about drilling horizons. G. O. Williams. *Oil Gas J.*, 15.6.59, **57** (25), 154.—Experimental work on the use of surface electrical resistivity measurements has shown that surface records can be correlated with one another and with electric logs of drilled wells. A technique has been developed giving log patterns which can be interpreted in terms of oil and gas saturation in sands and limestones. The equipment has an electrode arrangement with a movable electrode, exploration points being set 2 ft apart, using a very low power input of pulsating dc. A reliable log depends on: (1) exact measurement of distances between electrodes, and (2) elimination of leakage in the electrical circuits. The need for co-ordination of electrical data with existing geological and geophysical data is emphasized. C. A. F.

1330. Exploration problems?—electrical survey may do the job. C. A. Caswell. *Oil Gas J.*, 8.6.59, **57** (24), 232.—The use of electrical surveys in exploration is described. The technique has been hampered by failure to interpret the electrical data properly and to appreciate the significance of a vertical record, made at the surface, which can be correlated with the stratigraphic section, so providing improved subsurface interpretation. The electrical method can indicate formation thickness, it increases subsurface control, and costs compare favourably with other methods. Examples of surveys are given. C. A. F.

1331. Economical magnetic tape processing. J. M. Cunningham. *World Petrol.*, March 1959, **30** (3), 79.—A new automatic time corrector for data processing of seismic records is described. It is designed for use with the Techno T1–401 Recorder, and it includes dynamic correction for normal moveout to match any spread. There is convenient adjustment for inter-record spread-length changes. In weathering and elevation corrections, settings can be made for each channel, or multi-channel data can be pre-programmed. There is correction playback of all data during a single drum revolution. Details and a functional block diagram of the equipment are given. C. A. F.

1332. New navigation technique will increase aerial survey accuracy in remote areas. H. T. Brundage. *World Oil*, June 1959, **148** (7), 136.—The accuracy of aerial surveys has been improved by the use of self-contained radar Doppler surveying devices which are installed in the aircraft. Accurate navigation to guide photographic and magnetic surveys is now possible, with considerable savings in costs and time. The method is particularly useful in desert areas where accurate ground control is not available. The principle of the method is described: four microwave radar beams are transmitted obliquely downwards from the aircraft in the form of an X. The microwave energy is reflected from the earth's surface and is received by the aircraft, but as the receiver is moving relative to the ground the signal shows a Doppler frequency shift. This frequency is proportional to the aircraft's velocity so that ground speed can be determined. Drift angle can also be determined. Advantages and disadvantages are listed. There are limitations in accuracy over large areas, and rough water may give an erratic Doppler effect. The method has been successfully used in the central Sahara of S Libya.

C. A. F.

1333. Critical investigations on foundations of geomicrobiological prospection. (In German.) H. Völz and W. Schwartz. *Erdöl u. Kohle*, 1958, **11**, 69–72.—Applicability of the effect of volatile constituents of hydrocarbons and natural gas on the metabolism of hydrocarbon-oxidizing bacteria—widespread in the earth wherever hydrocarbons exist—as proof of an unknown or supposed but undiscovered petroleum deposit is examined. Patented direct methods are mentioned. The authors adopt an indirect method which consists of passing hydrocarbon vapours vertically through earth samples from different sources, in glass tubes 150–200 cm long and 5 cm dia, as illustrated. Characterization of the hydrocarbon-oxidizing bacteria by the titer method follows in a dil inorg nutrient soln. Sampling at depths from 150 to 250 cm is advised. A further earth sample may be taken at 50 cm depth to ascertain the specific production of the earth in hydrocarbons in the titer. The ratio hydrocarbon-oxidizing bacteria to total aerobic bacteria should be observed. As regards treatment of the samples titer estimation may be carried out in the field lab immediately after sampling or after storage at 5·5° C. 14 refs. R. T.

1334. Radioactivity in exploration. W. D. Crews. *Oil Gas J.*, 11.5.59, **57** (20), 391.—The use of surface radioactivity surveys in oil exploration is described. These have been discredited in the past because of low quality, inadequately interpreted surveys carried out with poor instruments, but it is claimed that carefully interpreted radioactive surveys carried out with sensitive detectors can give reproducible anomalies which are related to oil at depth. The causes of this relationship are obscure, and many hypotheses have been proposed. Details of the equipment required for these surveys are given, together with survey techniques which involve a gridwork of continuous traverses, or stationary point observations for inaccessible ground. Successful interpretation requires the recognition of and correction for the many variables which influence radioactivity measurements, *e.g.* climatic changes, application of fertilizers, and man-made structures. C. A. F.

1335. Microbes locate gas production in field test. R. J. Strawinski and W. B. Cox. *World Oil*, July 1959, **149** (1), 93.—Microbiological prospecting has been carried out in an area in SW Louisiana where a successful wildcat had been drilled, but no subsurface data were made available prior to the

survey. The technique is based on the theory that certain microbes in the soil feed on hydrocarbon gas which is escaping from a buried accumulation. Over a given area the presence of oil or gas is detected by the amount of activity shown by the bacteria. Results, shown as an anomaly map, demonstrated that two areas had anomalous hydrocarbon concn, and wells confirmed the presence of gas. C. A. F.

DRILLING

1336. World's deepest slim hole. R. E. Keen. *Petrol. Engr*, 1959, **31** (3), B30.—In drilling the Ginther, Warren & Co's O. W. Killam "A" No. 1 at Webb County, Texas, it has been proved that slim hole techniques can be successfully employed in ultra-deep 20,000-ft drilling operations. This well has been drilled under some of the most severe conditions to be found anywhere. For example, mud wt of over 19 lb/gal were used. The paper describes in detail the drilling operations of this slim hole, the mud programme, logging programme, testing programme, costs, etc., and gives the outstanding achievements of this well as: (1) the drilling of 2966 ft of $4\frac{3}{16}$-inch hole below 16,537 ft with hole temp ranging from 350° to 420° F; (2) the drilling of 2537 ft of $6\frac{3}{16}$-inch hole below 14,000 ft with ultra-heavy mud wt of 19·2 to 19·5 lb/gal and hole temp ranging from 300° to 350° F; (3) this was the deepest well in E and S Texas; (4) it was the second hottest well ever to be drilled in the world. M. F. M.

1337. How drilling costs are being cut in Canada. A. S. Murray and S. P. Mackay. *World Oil*, June 1959, **148** (7), 106.—Although drilling costs in W Canada have markedly decreased since 1948, it is important that new advances in drilling techniques should be applied to maintain or reduce present costs. Two important factors affecting costs are bit life and penetration rate; jet bits have been tested without favourable results, probably due to insufficient study of their proper application. Lighter weight drilling equipment should lower costs, and the use of high vol–low pressure centrifugal mud mixing systems to replace slush pumps will reduce maintenance costs and work more efficiently. The application of new drilling developments, such as air and aerated mud drilling, turbo-drilling, and slim-hole drilling, are noted. C. A. F.

1338. Are your tool joints being properly applied? Anon. *World Oil*, July 1959, **149** (1), 99.—Methods of removing worn or damaged tool joints from drill pipe are outlined. The best method is by heating with a dual purpose furnace, the joint being heated to 900° F, followed by quenching the inside of the pipe upset with a conical water spray. The joint must not be overheated. A method of applying double seal tool joints is noted. C. A. F.

1339. Jet powered junk retriever simple and effective tool. B. Honey. *Drilling*, June 1959, **20** (8), 93.—A new junk retriever uses a suction principle. The hollow chamber to retrieve the junk is evacuated by ejector jets supplied by the surface pumps, the tool being first run, open ended, to bottom. Catcher fingers at the entrance to the chamber retain the junk. Extremely good performance is claimed. J. C. M. T.

1340. Drill pipe and tool joints, drill collars, rock bits, diamond core and drill bits. Anon. *Drilling*, June 1959, **20** (8), 67–75.—A historical survey of the development of drill pipe and joints, drill collars, and roller and diamond bits. Some of the most significant were: the first tapered tool joint patented by Whittier, *ca* 1910; introduction of seamless pipe, *ca* 1914; upset pipe, *ca* 1919; the full hole joint, 1926, and its later developments; long drill collars, *ca* 1914; the Hughes roller bit of 1909; self-cleaning cone bits, 1925; the roller core bit, 1926, application of jets to roller bits, 1948; carbide inserts, 1915; the first diamond core drill of Leschot, 1863. J. C. M. T.

1341. New percussion drill may cut costs. Anon. *Oil Gas J.*, 11.5.59, **57** (20), 71.—A new air or gas drilling tool combines rotary and percussion action. Slightly strengthened roller-cone bits are used, and the tool is rotated slowly by the rotary table while an air- or gas-operated device above the bit provides the percussive action. No special surface equipment is needed. Field tests in Wyoming and Canada indicate that hole can be made two to five times faster than with normal equipment, and bits last up to four times as long owing to low rotating speed and lighter bit-weights. J. C. M. T.

1342. Hydraulics of turbo-drills; bench tests and field results. B. Dugallier and G. Lagacherie. *Rev. Inst. franç. Pétrole*, 1958, **13** (10), 1423–34.—After describing the turbo-drill the influence of the nature of the fluid is discussed, and attention is drawn to the effects of abrasive solids in the fluid, which lead to wear of various kinds. Bench tests of different types have been made on the turbo-drill in order to study the use of different fluids, the problems arising from wear, and other features. Field tests of the turbo-drill are reviewed and compared with conventional rotary drilling. In view of the nature of the favourable conditions for operating the turbine, it is pointed out that the use of conventional bits may not be ideal; bits may have to be designed for the turbo-drill. G. D. H.

1343. Turbo-drills. R. Delmas. *Rev. Inst. franç. Pétrole*, 1958, **13** (10), 1419–22.—The reaction turbine is driven by mud. A 10-inch dia turbine is available for $12\frac{1}{4}$-inch holes, and $7\frac{1}{4}$-inch turbine for $8\frac{1}{2}$-inch holes. Two 500-hp pumps are capable of giving at the bottom of 2000 m of 5-inch pipe 35 l/sec at 137 kg/cm² or 45 l/sec at 67 kg/cm² with 1·2 density mud. To limit erosion of the vanes mud velocities should not exceed 7 m/sec. Rotation speeds are often under 700 rev/min, although as much as 2500 rev/min has been used.

Conventional rotary may apply 10–100 hp at the bit; 250–300 hp may be possible with the turbo-drill, giving a correspondingly greater rate of advance.

The turbine may have 80–250 stages. As mud density is raised the same power is obtained with a smaller flow but a greater pressure drop in the turbine.

In hard rock at Saint-Bauzille the Neyrpic 80-stage 10-inch turbo-drill has given 10 times the advance for rotary; at Lacq the figure was 3–10 times. G. D. H.

1344. New technique decreases deflection drilling costs. R. P. Dwyer. *World Oil*, July 1959, **149** (1), 89.—The conventional methods of deflecting a borehole using whipstock, spud bit, and knuckle joint are time-consuming and costly, but the jet deflection technique permits a full gauge hole to be drilled with considerable savings in costs and without the risks involved in the older methods. This technique uses a conventional drilling assembly with a jet bit, two of the three jets being plugged; two small jets ($\frac{1}{4}$-inch or $\frac{1}{3}$-inch) and one large jet ($\frac{3}{4}$-inch or $\frac{7}{8}$-inch) are being used. On routine wells in the Gulf Coast area a well deflected up to 20° can be drilled in 15–20% more time than that required for the vertical hole, provided that the deflection point is not too deep. The jet deflection method is also useful for sidetracking in a well. C. A. F.

1345. Plugged and abandoned. C. R. Graham. *Petrol. Engr*, 1959, **31** (3), B121.—Phillips Petroleum Co's No. 1—EE University, the 25,340-ft wildcat in Pecos County, Texas, which holds the record as the world's deepest drilled hole, world's deepest fishing job, world's deepest whipstock, world's deepest cementing and perforating jobs, and world's deepest successful drill stem testing, has now been plugged and

abandoned. This wildcat has produced a wealth of new deep drilling tools and practices, geological knowledge, and a challenge to oil equipment manufacturers and service companies. M. F. M.

1346. New method used to repair shallow casing leaks. B. J. Woolley. *World Oil*, June 1959, **148** (7), 101.—A method has been developed for repairing leaking casing within the range 100–1000 ft, using left-hand drill pipe and a special back-off tool assembly to break and unscrew the corroded part of the string at the required depth. The defective casing is pulled from the hole, leaving the drill pipe in position. The new casing can then be run using the pipe as a guide. The method, which is simple and economical, has been used in the E Texas area, most jobs being completed within 26 hr. It has not been applied to deep strings, and the method may have to be modified for work below 2000 ft, due mainly to the low torque capacity of the power tongs. Details of the equipment are given. C. A. F.

1347. New techniques are opening up new areas to air and gas drilling. F. W. Smith. *World Oil*, May 1959, **148** (6), 188.—Successful operation of air and gas drilling depends primarily on proper interpretation of geological and drilling data from nearby wells. The main problem is water control, and the most important new techniques involve the use of chemicals to combat water influx, which can be divided into three groups: (1) weeping zones, less than 3 brl/hr; (2) intermediate flows, 3–50 brl/hr; and (3) heavy flows, more than 50 brl/hr. Weeping zones have been successfully treated using calcium stearate or silica gel as dry powder; this coats the cuttings, repels water, and prevents stuck pipe. With intermediate flows foaming agents have been successful, but no commercial foamants are entirely satisfactory. Air pressures need to be 100 psi higher than in dry drilling and hp requirements are increased by 10–20%. To combat heavy flows, complete or partial water shut-off is necessary, and several different materials have been used: (1) cement; (2) a polymeric water gel; (3) plastics; and (4) silicon tetrafluoride gas. The latter is a new development and is economical in cost and time. The gas is squeezed into the formation and an insoluble ppt is formed on contact with water. Equipment requirements for air drilling are tabulated. C. A. F.

1348. Reverse-wetting logging. J. W. Graham. *J. Petrol. Tech.*, Dec 1958, **10** (12), AIMME Tech. Paper No. 8041, 304–9.—Lab tests on brine-saturated cores showed that contact with a reverse-wetting agent caused little change in resistivity. However, when there was brine and residual oil, contact with the same type of agent led to increases in resistivity of 40–300%. The latter effect seems to occur immediately on introducing the agent; it persists and was not affected by heating to 150° F.

The reverse-wetting agent apparently causes the residual oil to wet the mineral grains, thereby interfering with electrical conduction. In a field test the suspected producing horizon was drilled through normally and logged. It was then reamed using a mud of the same resistivity but containing the reverse-wetting agent, and relogged. Both micrologs and microlaterologs showed marked resistivity increases in sections where invasion had left residual oil; the SP curve was flattened almost to the shale line.

This reverse-wetting logging technique may be useful in identifying hydrocarbons in thin beds, in highly invaded beds, in shaly formations, or in those with high water saturations. It may help in indicating *in situ* rock wettability. G. D. H.

1349. Drill-stem logging tool is successful. P. E. Chaney *et al.* *World Oil*, May 1959, **148** (6), 191.—A new logging tool has been developed which enables electric logs to be taken during the normal running of pipe out of the hole. A self-contained recording device is pumped down the drill pipe until an electrode assembly projects into the open hole through a passage in a jet bit. Logs are recorded as the pipe is withdrawn, or the tool can be retrieved by wire line. Logging costs are much reduced, and formation evaluation is improved, because beds are logged before invasion becomes excessive. The electrode assembly is flexible to facilitate egress into the open hole, and there is provision for resistivity and SP logs to be taken by recording on magnetic tape. Power is supplied by a self-contained battery, and depth control is also recorded on tape. An example of a log is included. C. A. F.

1350. Well logging—today and tomorrow. (The Atlantic Lectures of the University of Texas. Pt 4a). A. J. Pearson. *Petrol. Engr*, Feb 1959, **31** (2), B33.—Present logs help to find oil, guide testing, and aid reservoir engineers. Many unsolved logging problems, however, still remain. Log combinations, a new porosity tool, and computers promise more and better answers to search for oil in the future.

The paper reviews briefly the history of oil well logging and quotes the Elk City field in Oklahoma as an example of a field which was discovered solely by electric logging. It then deals with the fundamentals of electric log interpretation and the determination of resistivity and porosity. M. F. M.

1351. Displacement logging: a new concept in resistivity logging. (The Atlantic Lectures of the University of Texas. Pt 4b). W. C. Pritchett. *Petrol. Engr*, Feb 1959, **31** (2), B56.—Despite the progress made in recent years, the author believes that many holes which penetrated good reservoirs have been plugged and abandoned because of failure to detect the presence of producible oil. This failure is primarily the failure of the logging programme. What is needed in the field of logging is, therefore, a tool which will give a direct indication of the presence of producible oil. The tool should not respond to the presence of residual oil.

A new instrument called the " displacement logger " is now being developed which responds directly to the presence of reproducible oil but does not respond to residual oil. A number of displacement logs have been made in wells in Oklahoma and Texas. Low zones were detected in a number of known oil-bearing zones, and one or two new commercial zones were first pointed out by this tool. Some of the results are presented graphically in the paper; a diagram and description of the displacement logging sonde is also included. M. F. M.

1352. Varied logging programme required in the Paradox Basin. F. S. Millard. *World Oil*, June 1959, **148** (7), 141.—The Pennsylvanian Hermosa is an important producing formation in the Paradox Basin of Utah. It consists of limestone, dolomite, anhydrite, and salt, interbedded with organically rich shales. Pays are limestones and dolomites with vuggy porosity. γ-ray and neutron logs are widely used for correlation and formation evaluation. The sonic log has also proved useful for correlation, formation evaluation, and geophysical purposes. γ-density logs have had a limited use because the device is very sensitive to small borehole irregularities. The nature of the lithology makes quantitative interpretation difficult, and combination neutron–velocity and neutron–density logs are recommended. The SP log can be used to give a reasonable estimate of connate water resistivity if muds are fairly fresh. True resistivities are obtained with induction logs or focused devices. Examples of logs are given. C. A. F.

1353. Volcanic ash (pozzolan) improves oilfield cementing practices. C. M. Stout and J. E. Strassner. *World Oil*, June 1959, **148** (7), 114.—The use of pozzolanic additives with

Portland cement can reduce cementing costs by giving greater yields; slurries have lower densities, and there is lower fluid loss and better perforating characteristics. Greater resistance to oil well fluids has also been observed. Examples of field use of pozzolanic cements are given. Pozzolan is derived from highly siliceous volcanic ash and includes various reactive clays. 5 refs. C. A. F.

1354. Cementing 136,790 ft of hole. J. O. Woodson and C. L. Fulton. *Oil Gas J.*, 25.5.59, **57** (22), 170–89.—In the course of drilling the three extremely deep wells in Pecos County, Texas, Philips Petroleum Co performed 14 primary and 25 secondary cementing jobs, many of them below 20,000 ft, using commercially obtainable cements. No experimental materials were used. The development of cement mixtures suitable for such depths is reviewed. Common Portland cement alone is not suitable, since high temp and pressures reduce the thickening time. In the Pecos wells the thickening time was extended by using a carboxymethyl hydroxyethyl cellulose additive. Silica flour was also used to combat strength-loss at high temp and to control density. It was found more difficult to retard setting when the slurry weight was less than 13·5 lb/gal. Where bottom temp of 260° F or above are expected it is advisable to test cement blends before running. Details of the cementing programmes of the three wells are given. J. C. M. T.

1355. Effect of temperature on the flow properties of clay–water drilling muds. S. Srini-Vasan and C. Gatlin. *J. Petrol. Tech.*, Dec 1958, **10** (12), 59–60.—A Fann V–G meter was used to measure visc, yield values, and gel strengths at temp of 80°, 120°, 160°, and 180° F. The samples were mixed in a Hobart mixer and consisted of bentonite and water, bentonite, barytes and water, oil emulsion mud, and bentonite, barytes, water, and surfactant. Plastic visc and apparent visc decreased with rise in temp. Except for the emulsion muds, the data closely fitted the relationship $\log\ (\mu_p/\mu_w) = a + bT$, where μ_p is plastic visc of mud at T, and μ_w is visc of water at T. Yield values were given by $Y_B = 2(\mu_a - \mu_p)$, where Y_B is Bingham yield value in lb/100 ft^2 and μ_a and μ_p are the apparent and plastic visc of the mud in cP at the desired temp.

Yield value data showed considerable scatter. G. D. H.

1356. Laboratory study of effect of overburden, formation, and mud column pressures on drilling rate of permeable formations. R. G. Cunningham and J. G. Eenink. *J. Petrol. Tech.*, Jan 1959, **11** (1), AIMME Tech. Paper No. 8048, 9–15.—A 1·25-inch rock bit was used on 3·5-inch dia cores of Berea sandstone, and in a few cases on Indiana limestone and Austin limestone. Simulated overburden pressures ranged 2000–12,000 psi. For each mud column pressure ranged 0–1000 psi less than overburden pressure, and for each mud column pressure formation pressure varied from 0 psi to the mud column pressure.

Drilling rate was found to be independent of mud column pressure, provided that the difference between mud column and formation pressure was constant; the rate fell when mud column pressure exceeded formation pressure. Layers of cuttings held on the drilled surface by the excess pressure were subjected to recutting. Cleaning is essential for good drilling rates. High pressure differences require high jet velocities. When formation pressure exceeds mud column pressure drilling rate rises. Overburden pressure has little effect on drilling rates.

Care should be taken in applying these results to rocks of widely different physical properties. G. D. H.

1357. Rapid and accurate analysis of hydrocarbons in well site drilling mud. H. R. Chism, W. Scott, and R. A. Karas. *World Oil*, June 1959, **148** (7), 138.—A gas chromatograph unit for rapid and accurate analysis of hydrocarbons in the mud stream is described. Gas released from the mud at the surface is detected and measured for evaluation of potential producing zones. Limitations of earlier methods of detection are reviewed. The new equipment consists of two chromatographic units, air instead of helium being used as the carrier gas. Cat combustion detectors are used in place of thermal conductivity elements. There is automatic and repetitive recording of hydrogen and methane in one unit and, in the other, a complete chromatogram of the C_1 to C_5 hydrocarbons can be obtained by manual operation. The hydrogen and methane contents are plotted every minute and the C_1 to C_4 analyses can be made every 2 minutes if required, with a sensitivity of less than 1 ppm. The separator column for the chromatographic analysis is primarily a fractionating column, and correct interpretation is not difficult. Examples of hydrocarbon logs and a flow diagram of the equipment are included. C. A. F.

PRODUCTION

1358. Factors influencing the efficiency of miscible displacement. R. J. Blackwell, J. R. Rayne, and W. M. Terry. *J. Petrol. Tech.*, Jan 1959, **11** (1), AIMME Tech. Paper No. 8047, 1–8.—The experiments were designed to investigate both microscopic and macroscopic effects. Sand-packed tubes were used for the former purpose, and it was concluded that the mixing of miscible fluids is dominated by mol diffusion for reservoir conditions of rate, length, and pore sizes.

Various mobility ratios were used to examine macroscopic effects in reservoir models suitably scaled with respect to viscous, gravitational, and diffusional forces. Channelling is due to viscous fingering, gravity segregation, and variations in permeability. For adverse mobility ratios and reservoirs of realistic widths diffusion was not able to prevent the formation and growth of fingers even in homogeneous sands.

In horizontal reservoirs recovery at break-through decreases as mobility ratio increases, and the vol of solvent needed for complete recovery of the oil increases with increase in mobility ratio.

At sufficiently low rates gravity segregation in tilted reservoirs prevented channelling. G. D. H.

1359. Shell develops unique data recorder for automatic well testing. C. A. Sellars. *World Oil*, July 1959, **149** (1), 79.—A multi-channel analogue data recorder has been developed for recording and storing well test data. Using suitable readout apparatus, the data can be later presented in any required form, so that a more complete analysis of well producing characteristics is available. The equipment was first installed in the Bayou Sorrel field, Louisiana. The data recording unit consists of a standard eight-channel tape punch, and well performance data from the programmer are recorded on the tape using an identification code system. Methods of data processing and the readout counter system are outlined. C. A. F.

1360. Calculating recovery by cycling a retrograde condensate reservoir. W. C. Sheldon. *J. Petrol. Tech.*, Jan 1959, **11** (1), 29–34.—When the sand thickness is small relative to the well spacing the transition from producing reservoir wet gas to dry driving gas is sharp, and there is little dilution of reservoir gas by injected gas. When the sand is thick relative to the well spacing, variations in permeability are more important than the actual permeabilities. Absolute values of permeability fix the rate of gas injection and the economic limit of cycling; they have little effect on sweep efficiency. The vertical sweeping depends on the permeability range or distribution.

The V factor describes the kurtosis of the permeability

distribution curve. Curves have been derived to relate sweep efficiency with pore vol of gas injected for various permeability variations. An invasion factor is defined which is the total effluent divided by the contribution of wet gas. Invasion factors are given for various permeability variations. Applications of the concepts to production problems are outlined. Aided by a potentiometric model, the technique can be applied to individual wells.

Complications arise when the reservoir has dark oil, parts of which may be vaporized during cycling. G. D. H.

1361. Here's how to apply index of drive calculations. F. W. Cole. *World Oil*, June 1959, **148** (7), 119.—The material balance equation can be rearranged to show driving indices, the sum of these being unity. For max recovery the reservoir should be operated to give a max water drive index, the depletion drive index being held as low as possible. If the water drive is very weak and there is a fairly large gas cap, gas cap drive may be the most efficient. A diagram shows plots of drive indices against cumulative production for a typical combination drive reservoir. C. A. F.

1362. New subsurface flowmeter. R. C. Rumble, H. M. Buck, and B. A. Peters. *Oil Gas J.*, 11.5.59, **57** (20), 104–7.—A flowmeter capable of use within 2½- to 7-inch tubing or casing or in competent open hole is described. It consists of a cyl body which is lowered on a wire line in which is a single insulated inner conductor. At the required depth a rubber packer in the centre of the instrument is inflated by an electrically-driven pump situated in the upper half of the instrument. This diverts the flow in the well through a spinner-type meter in the lower half of the instrument, the rate and direction of flow being transmitted electrically to the surface. Flow rates of *ca* 10–1000 bd can be measured. Measurements may be repeated at intervals along productive or injection zones, and are of value in the analysis of reservoir behaviour and in the maintenance of individual wells. Examples of actual use are cited. J. C. M. T.

1363. Calculation of relative permeability from displacement experiments. E. F. Johnson, D. P. Bossler, and V. O. Naumann. *J. Petrol. Tech.*, Jan 1959, **11** (1), 61–3.—A method has been devised for calculating individual relative permeabilities for gas and oil or oil and water from data obtained during a gas-drive or water flood test on core samples 2–3 inches long and 1–2-inches dia. The theory assumes that flow velocity is constant at all cross-sections of the linear porous body, and that the flowing pressure gradient is high compared with the capillary pressure difference between the flowing phases (stabilized flow). The theory is outlined.

Tests were made which showed that the method gave reliable results which agreed with direct measurements of relative permeability obtained by steady-state flow tests. The method is less time-consuming than other reliable means for obtaining relative permeability data. G. D. H.

1364. Completing high pressure gas wells—mechanics and problems. R. A. Kilsdonk. *J. Petrol. Tech.*, Jan 1959, **11** (1), 35–7.—The wells considered are of medium high pressure, one being 13,505 ft deep, with a bottom-hole temp of 330° F. This well had 800 ft of 20-inch casing, 380 ft of 13⅜-inch, 820 ft of 9⅝-inch, 10,800 ft of 7-inch, 10,600 ft of 5-inch, and 3000 ft of 4·5-inch, the last two being set with barytes-weighted Slo-set cement. Prior to running this combination string the bottom 2000 ft of hole had been spotted with sodium gallate soln to prevent high temp gellation of the mud. An isolation squeeze was made of the zone to be tested, since the absence of scratchers and centralizers might have allowed cement channelling. Jet shots were used in perforating for this and other operations.

On test the tubing pressure was 6600 psi. 12,600 ft of 2⅜-inch tubing was used with 8450 ft of 1-inch tubing inside to permit injection of corrosion inhibitor (most corrosion in gas-condensate wells is in the upper two thirds of the flow-string). A special well-head arrangement was used, and the christmas tree proper had two 2-inch 15,000 psi test balanced stem master valves in the run and a single flow wing with two identical valves. G. D. H.

1365. Transfer of fluid components in a porous medium at constant saturation and fluid velocity. R. F. Neilsen and R. E. Gilchrist. *J. Petrol. Tech.*, Jan 1959, **11** (1), 57–60.—In displacing one gas by another in a porous medium with a relatively immobile liq present a transition zone exists in which there is a change from the composition of the original gas to that of the injected gas. The extent of this zone could be dependent on a mixing process in the direction of flow and on the rate of establishment of gas–liq equilibrium, if the gases are appreciably soluble in the liq.

Equations involving these factors are examined, and experiments have been made to study the relative importance of departure from equilibrium in determining the spread of the transition zone with time and distance for linear systems. The experimental results seem not to be out of line with the assumption of a rapid establishment of equilibrium made in the theoretical studies. G. D. H.

1366. Gas injection for attic oil recovery. J. C. Broom and A. L. Dowsey, Jr. *Petrol. Engr*, Feb 1959, **31** (2), B19.—A pilot project of attic oil recovery by downdip gas injection is being studied in the B-55 reservoir of the Venice field, S Louisiana. The injection phase was completed in May 1958, and oil has flowed at a high rate. Prior to the gas injection, the well had watered out, producing *ca* 98% water and only a few brl of oil. The paper describes in some detail the reasons for the choice of this particular reservoir, the operations carried out, and the results obtained. M. F. M.

1367. Tubular products: their design and application. (The Atlantic Lectures of the University of Texas. Pt 5). S. H. Davis. *Petrol. Engr*, March 1959, **31** (3), B52.—With casing and tubing accounting for half the cost of drilling and completing most new wells, much effort and talent must be devoted to the design and application of tubular goods.

The paper is concerned with economic and engineering factors of drilling, the tension and collapse factors on casing and tubing, and general tubing design factors. Defects on pipes and inspection and detection of such defects are described with the aid of some pictures. The main conclusion of the author is that tubular products in today's wells are so important that the industry's future may well depend upon the engineer's ability to match the properties of available products to the requirements of the well. M. F. M.

1368. Maintenance of reservoir pressure by water injection, Dollard field, Saskatchewan. L. Freitag. *Canad. Min. metall. Bull.*, 1959, **52**, 306–11.—The field is a stratigraphic trap producing crude of 23° API from a Jurassic sand at 4500 ft. 40 wells have been drilled on a 160-acre spacing pattern. Dissolved gas pressure is low, and the pressure in the field has declined rapidly from the original 1711 psig with the removal of oil. A study of the reservoir indicated the desirability of water flooding. Water is being injected at ten wells in areas where underlying water was present. Pressure is building up, and it is hoped to maintain an average pressure of 2700 psig. Oil production shows a steady increase. Although several wells show a large increase in water-cut, water breakthrough is not expected to occur for several years. G. B.

1369. Evaluation of reservoir performance. F. W. Cole. *World Oil*, May 1959, **148** (6), 193.—The efficiency of operation of a reservoir can be evaluated by rearranging the material balance equation. The procedure is given for a reservoir

containing a gas cap and water drive, and terms are rearranged to give three indices: Depletion Drive Index (A), Gas Cap Drive Index (B), and Water Drive Index (C). These are related by the formula: $A + B + C = 1$. The determination of the contribution of the gas cap to the produced gas may be difficult. C. A. F.

1370. Plastics reduce sand problems along the Gulf Coast. J. A. Harmon and J. O. Hendrick. *World Oil*, May 1959, **148** (6), 183.—Thermosetting plastic has proved very effective in combating problems due to loose sand in the Gulf Coast area. Sand production has long been a problem in the area, but the new technique enables the sand to be retained in place and not only blocked at the well bore. The plastic is thinned with alcohol, introduced as a liq into the well, and when in place it is polymerized by heat from the formation. During setting the alcohol separates out and the plastic hardens around the individual grains so that permeability is retained. Setting time can be controlled by adding cat. The method has many advantages including: (1) simple application; (2) hole remains clear; and (3) there is little risk of erosion by fine sand particles. In some areas of the Gulf Coast it is now standard procedure. Details of field tests are given, together with application techniques. 8 refs. C. A. F.

1371. Laboratory study of oil recovery by solution gas drive. L. L. Handy. *J. Petrol. Tech.*, Dec 1958, **10** (12), AIMME Tech Paper No. 8042, 310–15.—Tests were carried out on a 5-ft, 2-inch dia, 10-mD core of Bandera sandstone using a kerosine and a refined white oil which had gas-free visc of 1·8 and 25 cP respectively. The core was plastic encased and mounted so that external pressure could be applied. Initial saturation pressures were *ca* 2000 psia. In some tests production was maintained at a constant volumetric rate; in others the downstream pressure was dropped at a constant rate until it reached *ca* 200 psia, and then held constant.

High producing rates were found to increase oil recovery. The higher the oil visc, the lower the rate at which increased recovery was observed. All rates were much higher than average rates of pressure decline in oilfields. External gas-drive relative permeability data gave good recovery predictions at the lower rates, suggesting that the predictions on this basis should be satisfactory for oil reservoirs.

The instantaneous G.O.R. showed a sharp drop at the point where the minimum outlet pressure was reached, and then rose again on continued production.

The behaviour was explained by assuming that the gas phase was not continuous during much of the depletion process, but discontinuous gas flow occurs. Bubbles form in oil-filled pore spaces and gas diffuses to them. Rate effects are due to diffusion and flow control of gas saturations. G. D. H.

1372. Comparison of calculated k_{rg}/k_{ro} ratios with a correlation of field data. M. A. Torcaso and M. R. J. Wyllie. *J. Petrol. Tech.*, Dec 1958, **10** (12), 57–8.—For sandstone reservoirs where $1/P_c^2$ is approx a linear function of effective saturation lab data for systems wetted by connate water and yielding oil and gas (gas saturation growing)

$$k_{rg}/k_{ro} = (1 - S^*)^2[1 - (S^*)^2](S^*)^{-4}$$

where S^* = effective saturation $= So/(1 - S_{wi})$. This relationship has been compared with published field data presented as an empirical relationship for k_{rg}/k_{ro}. Good agreement was obtained for values of $S_{wi} = 0{\cdot}1$, $0{\cdot}2$, and $0{\cdot}3$; divergence was noted for $S_{wi} = 0{\cdot}4$ and $0{\cdot}5$. Divergence might be expected because the empirical relationship makes k_{rg}/k_{ro} infinite at a total liq saturation of $S_{wi} + 0{\cdot}25$. G. D. H.

1373. High pressure cycling with hydrogen sulphide-laden gas. C. O. Miller. *J. Petrol. Tech.*, Dec 1958, **10** (12), 25–8.—The Tidewater–Seaboard development of the New Hope (Franklin Co, Texas) Smackover reservoir has given seven producers. H_2S is 10–20 mol %, N_2 8–15 mol %, and CO_2 4–6 mol % in the well streams. The reservoir pressure was 5965 psia, temp 273° F, and dew-point 351 psia at this temp. Studies have shown that cycling and pressure depletion will give 35% more liq and 25% more gas than pressure depletion alone.

A pilot gas cycling plant has been in use since July 1957. *Ca* 6·7 MMcf/day was handled, giving 900 bd of H_2S-free condensate of 12 RVP, and 5·2 MMcf/day of gas for injection. Low-temp separation was used. Special materials to forestall corrosion were used only in valve trims and other speciality items. Hydrogen embrittlement has caused failures of springs, choke seats, and valve trims. Probes for corrosion detection have so far not been very satisfactory. Oil-soluble amine has been used to inhibit tubing corrosion and a water-soluble amine in flow lines.

Injection pressure is 5200 psig. For the first six months compressor maintenance was 0·1296 c/hp-hr, five times that for sweet gas. Most expense was on compressor rod packing and piston rings in the second and third stage compressor cyl.

Aq diethylene glycol was fairly successful in depressing hydrate formation. G. D. H.

1374. Gravel packing controls unconsolidated sand in Venezuela field. P. S. McReynolds. *J. Petrol. Tech.*, Dec 1958, **10** (12), 21–4.—Sand control has been a major problem in producing from the unconsolidated Miocene sands of the Lagunillas area. Combination oil strings with casing preperforated with 252 ½-inch holes/ft were usually unsatisfactory, as output was curtailed by small chokes in order to prevent excessive sand entry. Reliners with 0·01-inch slots inside this string controlled sand but usually cut output. Later 0·01-inch slotted liner was put opposite the sand, and this succeeded when the well could be washed until natural flow took place outside the liner. This technique will no longer be practicable when the pressure drops. In some areas the life of the slotted liner is relatively short.

On the Gulf Coast gravel packs inside perforated casing have been the most successful means of sand control.

The 10-percentile dia for the Bachaquero was 0·0098 inch, and 10- to 14-Tyler mesh gravel was used. Clean carrying fluids were found to be necessary to prevent slot plugging and reduction of gravel permeability. Salt–starch soln were satisfactory for open-hole packs. Oil, salt–water, or salt–starch soln was used for packs inside casing. For gun-perforated wells flowing or swabbing to remove drilling mud was needed before gravel packing. The techniques are described.

30 gravel-packed wells on production are producing decidedly faster than offsets not packed. Most were open-hole. The average section is 246 ft. G. D. H.

1375. Oil recovery by thermal methods. 1. T. W. Nelson and J. S. McNiel, Jr. *Petrol. Engr*, Feb 1959, **31** (2), B27.—Over two-thirds of the crude oil discovered in the U.S.A. is classified as unrecoverable by present producing methods. However, developments in thermal recovery methods promise that much of this oil will be produced economically. Three such methods are: (1) oil well heating; (2) hot fluid injection; and (3) *in situ* combustion.

Thermal methods have their most effective application in the recovery of low gravity oils. The markedly greater effect of temp on the visc and displacement efficiency of lower gravity crudes demonstrates an inherent feature of thermal methods that makes them unique among oil recovery processes.

A detailed description of the above three methods is given

in the paper. Equipments used are mentioned and the economics of each system discussed. M. F. M.

1376. Selection of a multiple completion hook-up. W. S. Althouse and H. H. Fisher. *J. Petrol. Tech.*, Dec 1958, **10** (12), 12–20.—Means for producing two or more zones separately through one well have been available for a considerable time. Multiple completions can save importantly on costs. A breakdown for a 10,000-ft offshore well suggests that the well costs may be $476,000, with the completion costs $49,000, $103,000, $150,000 for single, dual, and triple completions, respectively.

The equipment for multiple completions is described and discussed, and a graphic outline is given of multiple completion hook-ups, ranging from the simplest, most inexpensive two-zone completion to a four-zone completion. G. D. H.

1377. Flooding investigations on sandstone cores under deposit conditions. (In German.) C. Schmid. *Erdöl u. Kohle*, 1958, **11**, 149–52.—On account of the vast number of relevant factors the conventional formulæ for oil recovery determination—which take account of visc relation only—can give solely approx val. A basically better result is to be expected from flooding experiments if the substances concerned are adjusted as far as possible to deposit conditions. In the apparatus described and illustrated deposit oil and water at deposit pressure and temp are used. To avoid systematic error possibilities, such as end-effect, very long cores are used. Results of investigations under sp conditions are given in curves. The high pressure apparatus is not limited to the investigations mentioned. R. T.

1378. Ohio takes a look at slim hole completions. B. Johnson. *Drilling*, June 1959, **20** (8), 79.—An investigation into the practicability of slim hole completions for Clinton wells in Ohio is described. 2⅜-inch regular tubing was chosen as casing, and 1¼-inch upset tubing for tubing. Power was transmitted to bottom hole plunger pump by ⅝-inch wire line instead of rods, a long, slow stroke being used. The 2950-ft well has produced for 110 days without mechanical failures. Completion cost is *ca* $5000 (or 15–20%), less than for similar conventional well. J. C. M. T.

1379. More deep holes at less cost. E. Adams. *Petrol. Engr*, March 1959, **31** (3), B19.—To date 35 fields in the U.S.A. have produced oil and/or gas from below 15,000 ft. Seven were added in 1958. Now seven states have deep fields with 119 producing wells. Louisiana has 27 fields with production from below 15,000 ft. In the year 1958 some 135 exploratory wells were drilled at super-depths and 26 new fields were found, with 14 extensions to present fields. Costs were lower in 1958, but a well below 15,000 ft still costs an average of nearly $700,000. This year saw the lowest average drilling time in history—130 days/well. Single record is also lowest yet made—34 days taken to drill Shell Oil's No. 2 Weeks–Gall well in Louisiana.

The paper is a very comprehensive and complete technical and economic survey of drilling operations and operators in the U.S.A. during 1958. M. F. M.

1380. Down-hole plastic pipe installations draw interest. E. D. Edmisten. *World Oil*, July 1959, **149** (1), 91.—Application of plastic piping to borehole installations is reviewed. The pipe discussed is made of thermosetting resin bound with glass fibre, and it has been used successfully as tubing in salt water disposal wells, water supply wells, and shallow pumping oil wells. As the material is orthotropic, it cannot be rated in the same way as steel, and tensile collapse charts should be used in designing well strings; an example is given. In many production wells the tubing has eliminated or reduced rod failure. C. A. F.

1381. Minimize tubing failures caused by sand abrasion. M. L. McKee. *World Oil*, June 1959, **148** (7), 110.—Sand cutting of tubing set through upper zone perforations in multiple completions can be reduced or eliminated by providing a minimum number of perforations and by keeping these open with an oil squeeze or fracture treatment with ball sealers. The problem is particularly severe in the Gulf Coast area, where pays are mainly loose sands, and a group of wells showing tubing failures in this area has been analysed. Results of tests show that the number of effective perforations required to prevent tubing failures is generally less than that provided by standard procedures. A curve is given which can be used to determine the minimum number of effective perforations required to prevent tubing failures in most multi-completions. C. A. F.

1382. How to determine payout of well head adsorption units. F. H. Plitt. *World Oil*, June 1959, **148** (7), 120.—Adsorption by short-cycle hydrocarbon recovery units is claimed to be generally the most economical process for well head operations, lean gas streams being the most profitable throughput. The evaluation of an adsorption system should include a reservoir study and the determination of anticipated gas production, temp and pressure of the system, fractional analysis of the wet gas stream, and recovery required. Capital investment includes the cost of the unit and accessories, and a diagram shows a plot of stock tank recovery against investment. Another diagram shows average investment costs to be expected from varying design gas vol rates at a constant gpm content. C. A. F.

1383. Libya getting hotter. Anon. *Oil Gas J.*, 11.5.59, **57** (20), 84.—Dahra F-1, a stepout on the S of Oasis Oil Co's concession 32, Libya, has flowed 30 brl/hr of 41° API crude from 3160–3230 ft, and earlier swabbed 11 brl/hr from 3682–3690 ft, also finding gas at 3055–3150 ft. Two other areas in Libya which have tested commercial production are at Bir Tlacsin (Shell) and Zelten (Esso). J. C. M. T.

1384. One hundred years of progress in petroleum production engineering. H. H. Power. *J. Petrol. Tech.*, Jan 1959, **11** (1), 11–13.—A series of points are briefly reviewed, ranging from early exploration, drilling, cementing, and completion practices, to the kinds of equipment and materials needed for drilling the deeper wells to be expected in the future. Note is taken of the different engineering techniques and the development of reservoir engineering during the past 25 years. Many years ago Carll expressed the view that water flooding should be undertaken. Instruction in petroleum engineering began in 1912 at the University of Pittsburgh. G. D. H.

OILFIELD DEVELOPMENT

1385. Chlorine detection by the spectral log. W. R. Rabson. *Petrol. Engr*, 1959, **31** (3), B102.—Examples have been shown in which spectroscopic instruments of the neutron/neutron and neutron/gamma types may be used for detecting the presence of chlorine and therefore oil (by the absence of chlorine) under certain borehole conditions. It appears at present that best results in chlorine detection are obtained in cased holes logged at least 10 days after cementing. This is of great importance in providing a method of re-evaluating oil wells for missed oil-bearing zones, and following the movement of oil/water interfaces. As with all new well logging methods, the real merit of the spectral log technique cannot yet be fully determined. Its performance to date has been highly successful, leading to the construction of additional field units. M. F. M.

1386. North Dakota oil finders look at Nesson anticline. F. J. Gardner. *Oil Gas J.*, 15.6.59, **57** (25), 153.—The Nesson

anticline in the Williston Basin, N Dakota extends some 72 miles from N to S and plunges S at *ca* 30 ft/mile. There are several closed areas along its length containing fields, the largest being Beaver Lodge with a minimum closure of 100 ft and a closed area of *ca* 14 sq miles on the base of the Mississippian Last Charles Salt. A wildcat success ratio of 53% and a development drilling success ratio of more than 91% have been obtained in this area. C. A. F.

1387. New discoveries spur interest in Wyoming's Green River Basin. T. Dougherty. *World Oil*, July 1959, **149** (1), 85.—There have recently been important gas discoveries and developments in the Green River Basin in Wyoming, and the region is becoming one of the most important gas-bearing areas of the Rocky Mountain province. During the first five months of 1959 there were five gas discoveries and 18 wildcat completions, and increased activity is expected for at least five years. Pays are mainly Cretaceous Frontier sands, but there has been some Tertiary development, and exploration in the E of the area is largely directed towards Mesaverde prospects. Air–gas drilling has proved successful in the area, although some wells have had water problems. A typical drilling programme is outlined. Drilling depths are commonly 10,000–15,000 ft, and costs range from $5 to $15/ft. C. A. F.

1388. Tempo quickens on Lake Erie. B. C. Donnan. *Oil Gas J.*, 1.6.59, **57** (23), 222.—Offshore gas search in Lake Erie is being intensified during 1959, and approx 110 wells are planned. 56 offshore wells were completed in 1958, and there were 31 gas producers. Drilling is from towers and platforms in three sectors. In the W sector the search is for Dundee, Columbus, Salina, Guelph-Lockport, Trenton, and Cambrian production. Geophysical surveys have been carried out over many of the holdings. In the central sector three dry holes were drilled in 1958; there are few gas fields on land adjacent to this area. *Ca* 70 wells are planned for the E sector in 1959, where there will be much activity in the Medina gas play. Hydraulic fracturing has proved very successful here. C. A. F.

1389. Production tests are being made to evaluate Nigerian fields. V. S. Swaminathan. *World Oil*, May 1959, **148** (6), 200.—Several new fields were found in Nigeria in 1958 in the Port Harcourt area of the Niger Delta region and development of the Oloibiri and Afam fields has continued. These fields were producing a total of *ca* 6000 bd in 1958, and the crude is being shipped to Europe. The new finds are being evaluated, but terrain problems make development costly. These finds are at Soku, Ebubu (oil at 12,000 ft), Uquo, and Krakrama (oil at 12,000 ft). Continued exploration at a high level of activity is planned. C. A. F.

1390. Thailand's first oilfield will supply small refinery. Anon. *World Oil*, June 1959, **148** (7), 164.—An oilfield has been found in N Thailand at Mai Fang, where 21 successful wells have been drilled. Pay depths range from 800 to 900 ft, and average thickness is 20 ft. Oil gravity is 15°–17°, and indicated potential is *ca* 700 bd for the 21 wells. A refinery with a capacity of 1500 bd is nearing completion. Exploratory drilling is being carried out in an area 15 miles NW of the field, where stratigraphic tests are planned. A magnetometer survey is to be carried out in the Mai Fang valley. C. A. F.

TRANSPORT AND STORAGE

1391. Storage of liquefied gases. (In German.) H. A. Neuman. *Erdöl u. Kohle*, 1958, **11**, 89–94.—Advantages of spherical containers which are used largely for storing liq gases in place of the former cyl tubes are discussed. In this profusely illustrated article materials and constructional methods are described for the large space-saving containers. Welding, which has replaced riveting, is discussed fully. R. T.

1392. Pipelines in the common market. Anon. *Petrol. Times*, 19.6.59, **63**, 465.—Largely a report of a discussion by a German correspondent on recent proposals for crude oil pipelines from the Mediterranean to Switzerland and S Germany; the activities of the state-owned petroleum company Ente Nazionale Idrocarburi in aiming to create a source of supplies in the Middle East and North Africa are commented upon.

The Aigle plan is more comprehensive. It concerns not only supply to Milan's refineries but also an international pipeline via the Gt St Bernard Pass to Aigle and a third section extending the Genoa line to Munich.

The Rotterdam 24-inch dia line to the Lower Rhine is some 174 miles in length and should be in operation by mid-1960. Controversy still occurs re the rival claims of the Wilhelmshaven line, and the Wilhelmshaven jetty has been provided with facilities to handle 300 tankers pa.

A third pipeline is scheduled for construction by 1962 from near Marseilles to the Upper Rhine to supply refineries to be built on the French side at Strasbourg and in Germany at Karlsruhe. G. A. C.

1393. Spheroid separates batches in products pipeline. I. M. C. Barrett. *Oil Gas J.*, 15.6.59, **57** (25), 86.—The development is given by Shell Oil Co of a full-scale batch-separation programme for its 14-inch, 250-mile Wood River–Chicago products line.

Expandable elastomer spheroids at properly spaced intervals are introduced into the interfacial mixture between incompatible products at source, and their relative positions maintained. Advantages include ease by which they are gravity manipulated, relatively lower cost, and ability to nullify forward diffusion and substantially minimize backward diffusion.

The spheroids consist of two hemispheres of moulded elastomer vulcanized into a hollow expandable sphere. Technique of separation involves confining an originating vol of interfacial mixture existent between two incompatibles at source by judicious placement of required number of spheroids at interface and their movement in same relative position in stream to discharge end. Optimum spacing in the line in question is 120 lineal ft, and minimum time to by-pass a pumping station is 23 sec for each spheroid. The first spheroid must be inserted at beginning of originating interfacial mixture and subsequent spheres equally spaced throughout mixture. G. A. C.

1394. The pipeline spheroid—an effective technique for fluid separation. M. L. Barrett, Jr. *Pipe Line News*, June 1959, **31** (6), 35.—Shell Oil Co has been working towards the eventual development of a full-scale batch separation programme for its 14-inch, 250-mile Wood River–Chicago products line. This will provide for the introduction of expandable elastomer spheroids at properly spaced intervals into the interfacial mixture between incompatible products at the source of the line and the subsequent maintenance of their relative positions in the stream to destination. As a result of full-scale testing of the action of spheroids in this pipeline, graphs are presented which show some of the effects found in varying the number, size, and spacing of them as well as their overall effectiveness as mechanical separating devices for petroleum liq. Equipment has been developed for the precise high-speed launching of multiple spheroids. An automatic

spheroid by-pass is under development to permit their passage through intermediate booster pump stations.

Amongst the advantages of spheroids are the ease with which they can be manipulated by gravity, their relatively low cost, and their ability to nullify forward diffusion while substantially minimizing backward diffusion. In combination with automatic handling equipment, they offer a practical system for effecting savings by minimizing interfacial mixture generation to approx one-third of what it would otherwise be without mechanical confinement. M. F. M.

1395. Using expandable spheroids for batch separation. M. L. Barrett, Jr. *Pipe Line Ind.*, June 1959, **10** (6), 46.—Experience is reported of the use of precisely placed spheroids to limit interfacial mixing in a 250-mile, 14-inch products line. The spheroids are of moulded elastomer, have a wall thickness of 2·25 inches, and are expanded by a liq filling to a minor dia 1% greater than the id of the pipe. They must be placed at the head of the interface and at each point where the mixture of products becomes uniform, the last being in the pure trailing liq. In the installation cited, the optimum spacing is 120 ft. A minimum time spacing of 23 sec must be allowed to permit the automatic by-passing of pumps. With the use of nine spheroids the vol of interfacial mixture was reduced from 1000 to 240 brl. The launching mechanism and the by-passing arrangements at booster stations are described. The cost of the operation is much less than that involved in the similar use of dumb-bell scrapers. G. B.

1396. Winnipeg pipeline operates remote controlled electric station under severe conditions. A. R. Murdison and W. A. Kramer. *Pipe Line News*, June 1959, **31** (6), 28.—The Winnipeg pipeline system consists of 75 miles of 10-inch line connecting take-off tankage on the Interprovincial Pipe Line at Gretna with the Imperial Oil and North Star Oil refineries at Winnipeg. The type of design chosen for the station situated at Silver Plains is fully automatic and remote controlled. Once started, it runs automatically without supervision. Its pumping rate automatically adjusts to line conditions as determined by discharge pressure. Any abnormality, whether hydraulic, mechanical, or electrical in origin, will cause automatic shut-down of the affected equipment. Suitable indication is provided at the remote control point of all vital functions, including the booster station suction and discharge pressures.

A description of the station is given in the paper, together with details of operation and maintenance and also a number of pictures of control rooms and equipment used. M. F. M.

1397. Pipeline flow tests conducted on 24-inch natural gas pipeline. C. H. Klohn. *Pipe Line News*, June 1959, **31** (6), 44.—The paper describes the flow tests performed on an 11·896-mile section of 24-inch od X ·250-inch W.T. pipe. A range of flow rates was established, from 150 to 450 MMCFD. The purpose of these tests was to discover if interior cleaning (or coating) had any effect upon the deliverability of a natural gas pipeline, and the project was organized in three phases: (1) the section was tested after ten years operation; (2) the section was cleaned with two separately run wire brush type pigs; the section was tested after cleaning; (3) the section was cleaned and coated (MEK was used for cleaning and an epoxy resin for coating); tests were carried out after coating. Results are presented in tabulated form. M. F. M.

1398. Mixing crude with LPG, distillates in pipeline. A. N. Horne. *Pipe Line Ind.*, 1959, **10** (6), 68–71.—The 675-mile, 12-inch line from Cushing, Oklahoma to E Chicago has been converted to tight line operation and used for transporting a variable mixture of crude oil, LPG, and dist from several sources to the refinery. Large variations in the composition and throughput of the mixture necessitate close monitoring and flexibility of the pumping system. The refinery is advised seven days in advance of variations in the daily delivery. Gravity is continuously telemetered from the last station 24 hr in advance. The average composition of the mixture is 20–30% light hydrocarbons and 70–80% crude. G. B.

1399. What goes on inside a pipeline? H. J. Endean, R. M. Howard, and J. E. Knizner. *Pipe Line Ind.*, 1959, **10** (6), 62–7.—To test the possibility of making internal surveys of pipelines under normal operating conditions a pig fitted with pressure recording apparatus was constructed and run through an 8-inch line. The record yielded an elevation profile of the line and indicated leaks, sharp curves, and changes of gradient, and a surge during shut-down. The possibility of designing instruments for other internal surveys is indicated. G. B.

1400. Re-examination of the economics of sizing crude lines. L. Cookenboo, Jr. and L. W. Smith. *Pipe Line Ind.*, June 1959, **10** (6), 56–61.—For a line without loops and terrain with little variation, the throughput is a function of the power, id, and a const representing the gravity and visc of the oil. A chart based on this function shows the throughput obtained with any combination of power and id for a crude of 60 SSU and 34° gravity. The initial and subsequent costs, both of completed line of different dia and of power, are calculated on 1957 costs. All costs subsequent to installation are discounted to present value. The methods of computing the optimum station spacing and pipe wall thickness and of combining and differentiating these results to obtain the minimum total cost are explained with an example. G. B.

1401. Design features of the Laurel pipeline system. J. F. Stephenson and M. G. Jordan. *Pipe Line Ind.*, 1959, **10** (6), 52–5.—This line delivers 16 grades of crude to 18 take-off metering points. The communications, telemetering, and control systems are described. G. B.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1402. Small semi-automatic field plants. W. M. Miller. *Oil Gas J.*, 1.6.59, **57** (23), 135.—The Tidewater Oil Co uses pilot plant data to provide reliable information from planning and controlling refinery operations at their Avon and Delaware refineries. Long and short range economic studies can be made, yields on new units checked, and cause of unsatisfactory yields determined.

The data also provide for determination of optimum operating conditions, changes in procedure, selection of new processes, and sizing of new equipment or modifying the old.

Four small semi-automatic pilot plants and the cat activity decline testing unit were specially built and are small in size and run with minimum attention. The cat desulphurizing and reforming pilot plant, completed July 1954, has made 1500 successful runs, unattended for 16 hr/day. It consists of two identical units each capable of charging 100–1000 ml/hr of hydrocarbon feed. The reactors are 1 inch dia and 55 inches long and are heated in aluminium-bronze block assemblies. Automatic gas sampling is provided, controls are by two double-pole relays, taking 15 gal of charge stock and 300 g of

screened cat. An aging typical run takes six weeks; a programme cycle timer with 12 cams operates the unit.
G. A. C.

1403. Modern waste-disposal facilities at Shell's Anacortes refinery. E. D. Neumann, G. J. Reno, and L. C. Burroughs. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 293–303.—See Abs. **2032**, 1958.

1404. Bellow expansion joints. — Sayag. *Bull. Ass. franç. Tech. Pétrole*, 1959, 647–59.—Survey (illustrated) of various types, with reference to operating pressures and movements involved. Design calculations and stresses.
(Author's summary.)

1405. Pollution control at Ferndale, Washington. E. K. Daniels, J. R. Lutz, and L. A. Castler. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 282–92.—Pollution control at the Ferndale, Washington, refinery of General Petroleum Corpn involves the design and operation of the various processes used to control liq and air-borne wastes. The methods of water disposal chosen were dictated by stringent requirements set up by a state agency on the quality of effluent released into all state waters. Georgia Strait, on which the refinery is located, is used for sport fishing, commercial fishing, oyster culture, and recreation. It is also the main artery for the migration of salmon to and from the Fraser River in Canada. The refinery has six separate and distinct sewer systems to accommodate the various types of wastes. These systems are: oily process waste, sanitary waste, phenolic process waste, normal storm drainage, emergency storm drainage, and ships' ballast discharge. Wastes handled in the first three of these systems are subjected to biological oxidn to reduce phenols. Pretreatment of the various waste streams is essential in order to provide as uniform a feed as possible to the final biological oxidn waste-water treating equipment. Every opportunity is taken to regenerate alkaline soln used in treating petroleum products, thus enabling re-use of these soln and providing a further reduction in the load to the biological oxidn units. When strong spent caustic and potassium cresylate treating soln are no longer effective, they are enriched with the addition of excess hydrogen sulphide or cresylic acids, respectively, prior to sale. The use of stripped hydrogen sulphide gases in the spent caustic sulphiding tower has helped to reduce the quantity of this gas that has to be burned and, consequently, has reduced the emission of sulphur dioxide to the atmosphere. Floating-roof tanks are used extensively at the refinery to conserve hydrocarbons and reduce emissions to the atmosphere. Proper disposal of wastes in this area is an important part of the operations of the refinery. Therefore, every effort is made by the technical and operating staffs to maintain proper control in the waste-treating units to obtain a satisfactory effluent. (Authors' abstract.)

1406. Continuous RVP analyser cuts gasoline blending time in half. W. R. Foster and P. H. Richer. *Oil Gas J.*, 20.7.59, **57** (30), 82.—A continuous RVP analyser installation at Magnolia Petroleum Co's Beaumont, Texas, refinery is described.

Generally the Reid test gives results for motor gasoline some 5–9% lower than actual vapour pressure figure; the continuous analyser gave results with accuracy of $\pm 0{\cdot}1$ psi for range investigated, the standard Reid ASTM test giving reproducibility of 0·2 psi.

The instrument, which takes a sample of gasoline from a slip stream of the circulating pump, the blending system and after metering is passed to a vaporizing chamber at 150° F $\pm 0{\cdot}1$° F and pressure directly indicated is relatively simple and easily calibrated. By its use a significant amount of butane was upgraded to motor gasoline, with closer control of product vapour pressure, cutting blending time by half and eliminating tank reworking. G. A. C.

1407. The design of smokeless, non-luminous flares. P. D. Miller, Jr, H. T. Hibshman, and J. R. Connell. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 276–81.—Many refineries are finding it increasingly difficult to meet public demands for limiting the amount of smoke and light from safety flares. Although steam injection can make a flare less objectionable, it is often prohibitively expensive to use an effective quantity of steam. Esso Research and Engineering Co has developed a new flare, called the multi-jet, which promises an economical solution to most flaring problems. One installation has been in service for more than a year, and several others are being designed. The flare provides completely smokeless and noiseless burning, and its light is shielded by a stack 32 ft in height. The flare requires no aux utilities, such as steam or water, to make it smokeless. The multi-jet is usually sized to be smokeless and non-luminous for at least 95% of the expected occurrences of flaring. The flare stack is a steel shell lined with refractory material; the base of the flare is several feet above grade and contains one or more rows of multi-jet burners. The multi-jet burners are of simple design. They consist of a series of parallel pipes, or "burner lines," which traverse the bottom of the stack; each burner line contains a row of small nozzles discharging vertically into the stack. Solid rods of refractory material are mounted above and parallel to the burner lines. The flared gases impinge against this rod, or "flameholder," before they reach the ignition zone. During this period, enough air is mixed with the gas to give smokeless combustion. The paper presents complete design details of the flare as a contribution to industry. (Authors' abstract.)

1408. Considerations involved with the possible use of increased design stresses for pressure vessels and their effect on safety. G. E. Fratcher and A. F. Cota. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 233–8.—This report presents an analysis of the problems involved when considering the possible use of increased design stresses. The need for correlation of material properties with design-stress basis is given. The work of the Special Committee to Review Code Stress Basis of the ASME Boiler and Pressure Vessel Committee is outlined. The significance of non-destructive testing in correlation with design basis is developed. The limitations of non-destructive testing are set forth and the need for acceptance standards for all of the non-destructive tests is emphasized.
(Authors' abstract.)

1409. An investigation of the impact properties of vessel steels (A progress report). F. B. Hamel. *Proc. Amer. Petrol., Inst.*, 1958, **38** (3), 239–57.—This paper is a summary of the results of impact tests on 161 random samples of new vessel steels. Included is a statistical analysis of the properties of ASTM Specification A 285C steel, a review of the relative merits of A 285, A 212, A 201, A 204, and A 283 steels, as well as the results of computer correlation of the data. In addition, a comparison is made of this data on new vessel steels with similar data on old vessel steels. Of prime interest is the wide variation found in the impact resistance and in the grain size of these specimens. (Author's abstract.)

ABSORPTION AND ADSORPTION

1410. Selective adsorbents upgrade gasoline. G. R. Brown *et al.* *Oil Gas J.*, 8.6.59, **57** (24), 189.—Methods of operation and problems in use of mol sieves are discussed, the sieves being high-surface-area alkali metal aluminosilicate or zeolite. Adsorption is characterized by high selectivity and capacity for adsorption at extremely low partial pressures of adsorbable specie and at elevated temp.

A Mid-Continent light naphtha containing normal pentane and hexane was treated in a single step by passing over the adsorbent bed at 200°–55° F with hydrocarbon superficial

linear velocities up to 0·7 ft/sec. A table shows properties of the feedstock before removal of the normal paraffins.

Upgrading of reformer feed is more difficult, a heart distillation-cut being taken from the reformate before adsorption over a mol sieve bed at 400° F and 20 psig, giving a yield of 92·3% wt containing 83·2% aromatics and a CFR-R clear ON of 103·6.

A mol sieve process could be operated to remove trace amounts of butane in the alkylation process, since removal of normal butane from olefin feed by dist is difficult. Tables show composition of seven representative gasolines and regular and sieved reformer feed inspections. G. A. C.

1411. Molecular sieves in the petroleum and allied industries. — Debaty. *Bull. Ass. franç. Tech. Pétrole*, 1959, 591–621.—Chem comp and cryst structure outlined, preferential adsorption for polar and for unsaturated cpds, hence uses are drying, purification, and hydrocarbon separation. Drying power is exceptionally high (several times that of silica gel or alumina), examples discussed of drying applications include natural gas, H_2 from reforming plants, cracking gases. Methods of sieve regeneration (gas at 200° C) described and also dew point determination methods listed. Liq can be dried to below 1 ppm, *e.g.* jet fuels, transformer oil; examples, with operating and regenerating conditions, are given. Gas purification processes include removal of CO_2 from C_3H_8, removal of S cpds from natural gas. Liq purification includes removal of S from C_3H_8 and of paraffins from aromatics, naphthenes, and *iso*-paraffins. V. B.

CRACKING

1412. The economics of two-stage cat cracking. C. A. Rehbein *et al. Oil Gas J.*, 15.6.59, **57** (25), 108.—A brief description is given of the Shell Oil Co's plant which has been in operation at their Anacortes refinery for three years. Commercial experience with several types of feedstocks, results of engineering studies, and a summary of a detailed economic analysis of the process are also given.

Feed rate is from 13,000 to 30,000 bd and conversions from 65 to 90%, and data show that a substantial yield of high-quality gasoline is obtained.

The first-stage reactor is a riser lined internally with hex-steel and refractory for erosion protection. The second-stage reactor, designed for max flexibility, was built for cat inventories ranging from 30 to 120 tons. The regenerator is an elevated vessel for bottom draw-off of cat and countercurrent contacting of spent cat and air.

A number of cases were chosen for each of the five modes of operation to provide the most attractive over a range of conversion levels, and tables showing operating conditions, properties of products and cat, feed preparation, and a summary of economics is given. G. A. C.

1413. Catalytic cracking feed preparation. W. V. Medlin, J. C. Ornea, and A. J. Johnson. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 174–81.—Cat cracking is an important refining tool for the production of ever-increasing quantities of high-quality gasoline. The trend in feed preparation is to produce larger quantities of dist suitable for cat cracking feed. The most desirable combination of cat cracking feed preparation and cat cracking processes is considered. Vacuum flashing to high dist yields, limited by metallic contaminants carry-over, is shown to be attractive. Other feed preparation processes effectively reduce the metallic contaminants content of the dist feed. A simple combination of visc breaking and vacuum flashing of long residue, termed "flash cracking," is described. This feed preparation step is compared with solvent deasphalting of vacuum flasher pitch and fluid coking. Solvent deasphalting produces dist giving low coke makes in cat cracking; flash cracking is best from the standpoint of metals rejection. Flash cracking is somewhat more flexible and adaptable to changing market conditions because it can produce either No. 6 fuel oil or a small yield of unblended solid pitch. It is concluded that the best pattern for future refinery construction combines feed preparation for max yield and two-stage cat cracking. (Authors' abstract.)

1414. Improvement of catalytic cracking feedstocks by hydrogenation. M. D. Abbott, R. C. Archibald, and R. W. Dorn. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 184–92.—Hydrotreating of cat cracking feedstocks not only reduces the sulphur and nitrogen contents of the oil, but, under suitable conditions, converts a large proportion of the condensed polyaromatic cpds to mono-aromatics. In as much as the polyaromatic nuclei crack only with great difficulty and then give rise to excessive coke, while aromatics lead to aromatic gasoline components, hydrogenation of cat cracker feed benefits both the yield structure and product distribution resulting from cat cracking. An added benefit of hydrogenation is the removal of metallic contaminants of the oil which would tend to deactivate the cracking cat; in commercial operation accumulation of these metals has had no deleterious effect on the hydrogenation cat. Lab and pilot plant cat cracking of a variety of hydrogenated feedstocks indicates that coke yields are decreased by as much as 65% and gasoline yields increased by up to 20% as a result of hydrogenation. At the same time, sulphur and nitrogen are reduced to low levels, and the ON of the gasoline are improved. Commercial operations by Shell Oil Co of Canada Ltd have given results in good agreement with the lab data.
(Authors' abstract.)

1415. Tube by tube design of light hydrocarbon cracking furnaces using a digital computer. A. J. Andrews and L. W. Pollak. *Industr. Engng Chem.*, Feb 1959, **51** (2), 125–8.—Pyrolysis of light hydrocarbons is of growing commercial importance for the production of olefins which are used in the manufacture of petrochemicals. A programme was developed for the design of tube furnaces for thermal cracking, using a medium-sized digital computer.

By machine computation, a furnace design may be obtained with speed and precision of calculation for butane, propane, or ethane feedstock. Composition, temp, pressure, and enthalpy of the gas and the skin temp of the tube are determined for each tube. For a given furnace design, the effect of such variables as type of feed, heat flux, pressure, temp, steam rate, and feed rate on furnace operation and olefin yield may be predicted. Calculated results are compared with commercial furnace data. M. F. M.

1416. Unifining—some operating cost information. W. J. Baral, L. R. Damskey, and G. W. Hendricks. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 199–202.—Unifining was introduced early in 1954, and since that time has been widely accepted by the petroleum industry. This paper presents operating cost information from four typical units, each in a different service and in a different refinery. The Unifining units vary in size from 900 to 16,000 bd, and feedstocks range from straight-run naphthas to cracked gas oils. Refiners' direct costs were obtained for operating labour and supplies, maintenance, utilities, and cat. The sum of these costs for the examples cited range from 4·5 to 8·9 cents/brl of feed processed. Cat costs are especially low, ranging from 0·8 to 1·2 cents/brl of feed. Three of the four units expect a lower cat cost than that reported. (Authors' abstract.)

1417. Commercial Unifining of distillates and gas oils. C. F. Gerald and L. O. Stine. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 193–8.—The applications of Unifining and other hydrodesulphurization processes have grown at an astounding rate

in the four years that they have been in commercial use. The total feed capacity, installed, in design, and under construction, now exceeds 1 million bd. Unifining has two general fields of utility: the purification of naphthas for subsequent processing; and the hydrogen treating of refinery products heavier than naphthas to improve marketability. The latter is discussed in detail in this paper. Data from commercial operations are presented to illustrate three ways in which Unifining is used to increase refinery profitability. These methods include hydrodesulphurization, saturation of olefins, and other unsaturated cpds. The first application is directed to the improvement of product quality, *e.g.* the desulphurization, colour and odour improvement, and greatly increased colour stability of a previously refined product. The second discusses the upgrading of refinery streams to permit their utilization in more valuable products than is practical without Unifining, such as the conversion of high sulphur cat cycle oil from an industrial fuel classification into high quality railroad diesel fuel, low in sulphur and essentially olefin-free. The third application relates to the processing of lower cost, high sulphur crude oil fractions into products at least the equal in quality to those made from otherwise equivalent sweet crude oils—in many instances, one of the few ways in which these high sulphur crude oils can be utilized. Also discussed are the feasibility of manufactured hydrogen to supplement available by-product hydrogen, cat replacement *v.* cat regeneration, current investment and operating costs, and the future for Unifining. (Authors' abstract.)

HYDROGENATION

1418. Hydrogenation—here today and here tomorrow. W. E. Bradley *et al.* *Oil Gas J.*, 8.6.59, **57** (24), 194.—The present and future status of hydrogenation in the manufacture of premium refinery products is reviewed.

Hydrogenation of gasolines and naphtha pretreats feedstocks prior to reforming to yield desirable feeds. Feed treatment reduces sulphur content and improves gum stabilities. Kerosine treatment by hydrogenation results in a doctor sweet product of +30 Saybolt colour. Lub oil quality can be improved, and wax can be commercially upgraded.

Tables show commercial plant data for various feeds, and one gives hydrocracking characteristics of cat. G. A. C.

CHEMICAL AND PHYSICAL REFINING

1419. A countercurrent adsorption column utilizing fluidized beds. A. Hamburger and W. H. de Groot. *Ingenieur, 's Grav.*, 12.6.59, **71** (24), Ch 11.—A unique column for treating large quantities of impure gas is described. The column consists essentially of two fluidized beds one above the other interconnected with a stand-pipe. The fresh adsorbent material is added to the top of the column and the spent material is removed from the bottom. If the gas stream is cut the beds collapse and settle on suitable gauzes. The rate of addition and removal of the adsorbent material to and from the column depends on the amount of impurity in the gas and the quantity of gas to be treated. The advantages of this system over the normal fixed-bed column lie in the continuous removal of the contaminated adsorbent material from the column and the greater contact efficiency between the impure gas stream and adsorbent material. Good heat distribution and better heat removal from the column were also experienced. The overall efficiency of the column was found to be greater than 70% irrespective of operating conditions. D. C. E. deW.

1420. How to get optimum use of by-product hydrogen. G. T. Gwin. *Oil Gas J.*, 1.6.59, **57** (23), 129.—Full-scale platinum reforming of virgin naphtha provides adequate supplies of hydrogen for hydrotreating all fractions of the crude charge. Included are all primary fractions, except the light ends, and treating of naphtha and heating-oil products from cat cracking, lubricants, aliphatic solvents, and paraffin wax.

The hydrogen is usually in the range of 500–1100 scf/brl of feed, a representative one being 500–750 scf/brl, of 80% purity from naphtha and 50–70% from reforming. A scheme for processing 100,000 bd of a high sulphur crude oil is given, various hydrogen-treating operations are listed, the vol of oil processed and approx hydrogen consumption shown; consumption of hydrogen for all the operations is only 41% of hydrogen available from crude naphtha.

A scheme, not yet commercially in use, for hydrogenation of asphalt fraction for conversion to lighter products is outlined.

Humble's hydrogen-treating capacity at present is *ca* 55% of its total crude oil charge, and types of oils and approx vol now being hydrotreated are listed.

Another table shows quality improvement from hydrogen treating as employed by Humble, H_2S impurity being scrubbed from the hydrogen tail gas at several points to yield *ca* 87% pure hydrogen. Some 150 tons/day of H_2S are recovered. G. A. C.

SPECIAL PROCESSES

1421. Water washing for acid gas removal. J. G. Burnham. *Petrol. Engr*, Feb 1959, **31** (2), C15.—In recent years the conc of CO_2 and H_2S in some gases has generally increased and 20–30% CO_2 or H_2S in raw gas is not now uncommon. Recent installations and studies have shown that Aquasorption, the old process of water washing, is a practical process for gas sweetening, particularly with high H_2S to CO_2 ratio. The greatest advantages are the flexibilities available in design to meet the varying requirements of acid gas removal so as to deliver the max vol of gas for sale. The paper gives a brief design and economic report. Comparison of the costs of Aquasorption with amine process shows the economic desirability and advantage of the former method. M. F. M.

1422. Synthesis of hydrogen cyanide by autothermic reaction. P. W. Sherwood. *Petrol. Engr*, Feb 1959, **31** (2), C22.—Several commercially feasible processes are available for synthesis of hydrogen cyanide, but two processes, namely, dehydration of formaline and the reaction of methane and ammonia, are in actual commercial use. The methane and ammonia reaction is of foremost importance and the synthesis is carried out autothermally, *i.e.* in the presence of air. Formation of HCN from ammonia, methane, and oxygen takes place via two routes. One, the endothermic direct reaction between methane and ammonia:

$$CH_4 + NH_3 + 60\ \text{Kcal} \rightarrow HCN + 3H_2$$

The second main reaction appears to proceed as follows:

$$NH_3 + O_2 \rightarrow NH_2O_2 \rightarrow HNO + H_2O$$

$$HNO + CH_4 \rightarrow NHCH_2 + H_2O \rightarrow HCN + H_2 + H_2O$$

$$NH_3 + O_2 + CH_4 \rightarrow HCN + H_2 + 2H_2O + 66\ \text{Kcal/mol.}$$

Accompanying these main conversions are several side reactions which lead to formation, in small amounts, of CO and hydrogen. In commercial practice a cat (platinum base) is almost universally used to accelerate the main reaction and thus the residence time, at 1000° C, for completion of conversion is reduced to $\frac{1}{10000}$ sec. M. F. M.

1423. The Oxo process today. V. N. Hurd and B. H. Gwynn. *Oil Gas J.*, 8.6.59, **57** (24), 199.—Recent developments in the Oxo method of converting olefins to aldehydes are reviewed, and a comparison of three methods of manufacturing primary octyl alcohols is given.

Reactants in the Oxo process are synthesis gas, olefins, and a cobalt cat; and if alcohols are the goal, hydrogen as well.

The cat is formed from cobalt under the usual Oxo conditions and the cobalt may be introduced in a variety of forms. The cat is not poisoned by presence of sulphur, but this should be eliminated.

For heptene oxonation there is a wide variation in the oxonation rates of various pure olefins under a given set of conditions.

Further processing of Oxo product is necessary to remove cobalt, involving heating, extraction with dilute acids, or removal as an insoluble oxalic acid salt.

Hydrogenation and dist combined produce materials containing quite low concn of aldehyde present from the process.

It is concluded that the Oxo process will continue to be a growing means of converting olefins to aldehydes, and additional Oxo derivatives, such as acids, amines, polyols, and others, will appear in increasing numbers. G. A. C.

1424. Sulphur recovery from refinery gases. R. W. Rieve, P. M. Pitts, and L. N. Levm. *Oil Gas J.*, 8.6.59, **57** (24), 180.—The new process developed by Atlantic Refining Co uses a basic aq soln of a multivalent ion such as iron in conjunction with a chelating agent to absorb hydrogen sulphide and oxidize it to sulphur. The operation is continuous, since the iron is re-oxidized by air either concurrently or separately. The sulphur is produced as a finely divided solid recoverable by settling, filtration, or as a liq by heating the suspension above mp.

Tables show oxidn of H_2S by aq $FeCl_3$, and by ferric versenate.

The process has been studied only on a lab scale, but it would appear that two processes could be possible, one for converting H_2S alone to sulphur, the other for producing sulphur directly as the H_2S is being removed from a hydrocarbon gas stream. G. A. C.

1425. Scme developments in polymers from petroleum. P. V. Smith, Jr. *Industr. Engng Chem.*, March 1959, **51** (3), 248.—A major fraction of the ever-growing volume of petrochemicals finds its way into polymeric materials. Five polymeric products, now in the market development stage, are discussed in the paper: one elastomer and four oily polymers. A chlorine containing copolymer of *iso*butylene and isoprene overcomes many difficulties encountered with butyl rubber. Four polymeric materials based largely on butadiene appear to have outstanding promise in a variety of applications.

M. F. M.

1426. Radiation-induced reaction of hydrocarbons with *n*-butyl mercaptans. N. D. Nevitt, W. A. Wilson, and H. S. Seelig. *Industr. Engng Chem.*, March 1959, **51** (3), 311.—Heptane, methyl*cyclo*hexane, 1-octene, 2-octene, and benzene, each containing varying amounts of *n*-butyl merceptan, were subjected to γ radiation. The mercaptan was converted to sulphides and disulphides by hydrocarbon free radicals formed by the absorbed radiation.

With the paraffin and aromatics, the amount of mercaptan reacting depends only on the amount of energy absorbed. With the olefins, the amount of reaction depends also on the mercaptan concn. Reaction is inhibited by aromatics and promoted by olefins.

The effectiveness of radiation in such an application as sweetening of petroleum therefore depends heavily on aromatic and olefin contents. M. F. M.

1427. Houdry dehydrogenation for olefin production. L. Friedman, D. E. Womeldorph, and D. H. Stevenson. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 203–12.—The Houdry dehydrogenation process was developed during world war II to provide a new means of making butadiene to meet national requirements of this most important raw material for the manufacture of synthetic rubber. Expansion of national synthetic butadiene rubber (SBR) capacity by private industry, following government "decontrol" of the industry and disposal of government-built facilities, brought about an increase of approx 400,000 tons in annual national butadiene capacity. Of this increase, six new Houdry dehydrogenation process units, placed on-stream commercially during 1957, accounted for 60%. Described herein is the fixed-bed, multi-reactor, single-step process, which employs a chromia–alumina cat to convert plentiful *n*-butane feed to butadiene, butylenes for aviation alkylate, or both products concurrently. Typical pilot plant and commercial data are reported for concurrent butadiene–butylene production, and for butadiene and butylenes as single ultimate products. Lab data are also given for production of *iso*prene, *iso*butylene, and propylene from appropriate charge stocks by this versatile, commercially proved cat process. (Authors' abstract.)

1428. Experience with vessels of delayed-coking units. N. A. Weil and F. S. Rapasky. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 214–32.—High temp, cyclic service, and rapid turnround in delayed coking subjects the associated coking pressure equipment to unusually rigorous demands. As a result, numerous maintenance difficulties, not generally associated with continuously operating units, have been encountered. This paper summarizes the results of an extended survey conducted on 16 delayed-coking units. The maintenance problems are listed according to categories, and a general discussion is presented regarding their significance, including recommendations for their correction or minimization on existing as well as future installations.

(Authors' abstract.)

1429. Catalytic synthesis of *cyclo*pentadiene hydrocarbons. (In German.) N. I. Schujkin and T. I. Naryshkina. *Erdöl u. Kohle*, 1958, **11**, 153–6.—*cyclo*Pentadiene and its homologues can be prepared by cat dehydrogenating cyclization of alkadienes and cat dehydrogenation of five-membered cyclenes and cyclanes. Yields of *cyclo*pentadiene hydrocarbons in cat dehydrogenating cyclization of alkadienes amount to 18–47%, depending on composition and structure of the original hydrocarbons. Cat dehydrogenation of cyclenes gives larger yields—up to 58%—of corresponding *cyclo*pentadiene hydrocarbons. Under the same conditions *cyclo*pentane and methyl*cyclo*pentane are dehydrogenated to the corresponding *cyclo*pentadiene with yields from 14 to 31%. Optimum experimental conditions for formation of *cyclo*-alkadienes from alkadienes (C_5, C_6) and cyclenes are 600° C and 20–25 mm pressure. Establishing is important—from a theoretical and practical viewpoint—that branched alkadienes with 6 C atoms on dehydrogenating cyclization tend much more to formation of *cyclo*pentadienes than the linear pentadiene. 41 refs. (Authors' abstract.)

1430. H_2S to S by direct oxidation. H. Grekel. *Oil Gas J.*, 20.7.59, **57** (30), 76.—Pan American Petroleum Corpn has investigated conversion of H_2S to S by direct cat oxidn in the presence of gaseous paraffin hydrocarbons or other gases. By the process H_2S could be selectively oxidized without concurrent oxidn of paraffin hydrocarbons, and has been proved in lab and pilot scale plant. The process is a modification of the Claus process.

The direct oxidn process is best with low H_2S concn; if above 25% H_2S more than two stages are necessary and plant costs are greater. Investment for direct oxidn would be approx 60% of that for conventional Claus process units.

To date no commercial application of the direct process has been made, but a design is given together with a pilot plant flow sheet and graphs showing effect of max bed temp on

hydrocarbon oxidn at 90–100% oxygen conversion and composite bed bench scale oxidn of H_2S to sulphur. G. A. C.

METERING AND CONTROL

1431. Instrumentation and computation. Anon. *Petrol. Times*, 5.6.59, **63**, 432.—A joint symposium under the ægis of the British Conference on Automation and Computation, May 1959, is reported upon.

Emphasis was on control, four papers were devoted to improvement of process efficiency, factorial experiments employing the Box and Wilson principle being described.

In the paper "Correlation Analysis of a Heat Exchanger" it was shown that misleading results can be obtained by an unwise choice of method of analysis.

The use of a digital computer for systematic examination of the steady state of a super-fractionator column with a throughput of 9000 bd was described.

A wide field of computer applications was ranged over during the session on process control. The application of on-line computers was another subject, and a paper, "The Use of Simple Computers in Electronic Process Control Loops," introduced a new device employing force balance transducer principles.

A generalized session dealt with the design and use of analogue computers, and the fifth and final session concerned computer techniques in large and small companies, the paper "Process Investigation and Plant Design in Large and Small Companies" giving a valuable outline of some possible organizations, a discussion on costs of computer services, and suggested ways in which the smaller units of industry might best be served. G. A. C.

1432. Chromatographic control of Magnolia's alkyl unit. L. J. McGovern and L. J. Carlisle, Jr. *Petrol. Engr*, Feb 1959, **31** (2), C6.—A vapour phase chromatograph, consisting of an analyser, a control unit, and a recorder, has been installed for the control of a de-*iso*butanizer tower on an alkylation plant at Magnolia's refinery in Beaumont. This chromatograph showed that the composition of tower products varied over a wide range, even under seemingly stable tower conditions. This previously undetectable variation in product composition was costing the refinery several thousand dollars/month. The chromatograph has proved its ability to give accurate, reproducible analysis and needs only nominal maintenance. Operating personnel at the unit have accepted the chromatograph as an aid in controlling their tower. The entire refinery operation is now being surveyed for possible applications of chromatographic control to produce quality products at max yield. M. F. M.

PRODUCTS

CHEMISTRY AND PHYSICS

1433. Flow properties of distillates at low temperatures: a review. J. F. Hutton. *J. Inst. Petrol.*, 1959, **45**, 123–9.—Conventional tests for assessing the lower temp limits of use of dist fuels and lubricants, namely, cloud and pour point, are critically reviewed. It is concluded that these tests should not be used as criteria of flow properties, and particularly should not be applied to lab investigations designed to find rules for the correct selection of additives for improving low temp flow properties of oils. A review of mechanisms by which additives increase fluidity led to the conclusions that the most likely mechanisms are surface adsorption and change of crystal habit and size by co-crystallization, both of which lead to a reduction in inter-particle attraction. A third mechanism, namely, the formation of eutectic mixtures, which would result in a lowering of the crystallization temp, is not considered to be important. A. D. S.

1434. Initiation of thermal reactions by the flash illumination of absorbing bodies. J. L. Lundberg and L. S. Nelson. *Nature, Lond.*, 1959, **183**, 1560–2.—Calculations show that if graphite particles are suspended in a liq hydrocarbon and subjected to radiation, the particles become heated to a temp which passes through a max if the particles are spheres or cyl of size of the order 10 μ, and which is sustained at a much higher value if the particles are plates of size <1 μ.

Experiments are described which make use of this effect. The system was contained within a vessel placed along the axis of a spiral quartz discharge lamp, which was flashed from capacitors at 400 V using 5000–10,000 joules. By this means methane was pyrolysed in the presence of 7·5 μ W wire. Mineral oil was pyrolysed using molybdenum (<74 μ) and carbon (<36 μ) powders, glass wool (8 μ) and W wool (7·5 μ). Above a threshold energy carbon was formed, effervescence occurred, and the oil fluoresced under 3661 Å radiation. The filtered oil showed an absorption spectrum similar to that of degraded high-voltage insulating oil.

Experiments with polymers are also described. H. C. E.

1435. *cyclo*Pentadiene; properties and uses. — Moulin. *Bull. Ass. franç. Tech. Pétrole*, 1959, 563–88.—Structure and phys properties (including dimer and conversion (cracking) of latter to monomer); main chemical reactions (addition reactions, reactions with alkali metals and of the CH_2 group, derivatives yielded by halogenation, hydrogenation, oxidn, ketene) and also those of dimer. Uses of monomer and dimer; resin manufacture, drying oils, insecticides, fungicides, pharmaceuticals, dyes, perfumes, lub additives.

(Author's summary.)

1436. Investigations to detect the atmospheric conversion of sulphur dioxide to sulphur trioxide. A. L. Chaney. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 306–12.—In the gaseous state the sulphur dioxide is only very slowly oxidized to sulphur trioxide. It has been recently suggested that in the presence of fog and particulate-matter cat, this oxidn may be greatly accelerated. If oxidn does occur, both sulphate and acidity of the particulate matter should increase. Because nitrate is frequently also present in significant quantities, its relationship to acidity should also be known. Techniques have been developed for testing this hypothesis in the Los Angeles area. Particulate matter was collected and weighed in two separate fractions based on particle size, and aq extracts of it were prepared for determination of acidity, sulphate, and nitrate. Larger particles were collected by dry impingement and the submicron size by filtration through membrane filters. Fog droplets, if present, would be in the first fraction. Simultaneous sampling for sulphur dioxide concn was carried out by a highly sensitive and specific procedure. The sampling period was one hr, and provision was made for automatic collection of several successive samples at intervals throughout a 24-hr period. These samples were sufficient in size for measurement of both total wt and wt of the water-soluble fraction. Chemical determinations in the microgram range were utilized for the sulphate, nitrate, and acidity measurements. The general techniques used may be extended to include the determination of a number of other constituents of particulate matter as well. In this investigation the sulphur dioxide was usually very low in concn and was not well

correlated with sulphate levels. Other sources besides sulphur dioxide may be required to account for the sulphate levels found in the particulate matter. A large fraction of the particulate matter was found to be water soluble, particularly in the submicron fraction, and it contained acidity which could not be accounted for in terms of the sulphate and nitrate levels found. The results were evaluated in comparison with meteorological and released data. (Author's abstract.)

1437. Oxidant plant damage from ozone-olefin reactions. E. F. Darley *et al.* *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 313–23.—The reaction of ozone with five-, six-, and seven-carbon olefins is quite rapid even in the gas phase at concn of a few ppm. These reaction mixtures produce a toxic material causing damage symptoms on pinto bean plants which are indistinguishable from those attributed to oxidant-type air pollution. Ozonides, formed in small yield by this reaction, are stable materials which do not damage pinto beans in any way even at concn higher than those arising in ozone–olefin reaction mixtures or in outdoor air. Evidence was obtained that the toxic material is unstable even at low concn in air. Its half life appears to be no more than a few minutes. This result suggests that either a transitory ozone–olefin complex or an unstable zwitter ion formed by its decomposition is the actual toxic substance. Attempts to confirm this by adding excess aldehyde or sulphur dioxide to scavenge the toxicant were not successful. (Authors' abstract.)

1438. Nylon capillary columns for use in gas–liquid chromatography. R. P. W. Scott. *Nature, Lond.*, 1959, **183**, 1753.—A nylon column 1000 ft by 0·02 inch dia was coated with dinonyl phthalate and used in conjunction with a micro argon detector. A light petroleum fraction (bp $<100°$ C) was passed through at room temp; *n*-butane, *n*-hexane, and *n*-heptane were eluted in *ca* 60, 90, and 170 minutes, and the isomeric hydrocarbons were also separated. The efficiency of the column varied from $\frac{1}{2}$ to $\frac{1}{4}$ million plates. H. C. E.

ANALYSIS AND TESTING

1439. Chromatographic resolution of petroleum porphyrin aggregates. R. C. Fisher and H. N. Dunning. *Analyt. Chem.*, 1959, **31**, 1194–7.—Mixtures of polar and non-polar porphyrins from petroleum were fractionated by chromatography on a column of partly deactivated alumina. The porphyrin aggregate was added to the column in a small vol of benzene. Four fractions were obtained by eluting successively with benzene, benzene + dioxane, benzene + ethanol, and H_2O + ethanol. These fractions were characterized by their spectra and their R_f values on paper with the solvent systems $CHCl_3$/alkane and lutidine/H_2O. The last fraction isolated from the column was a porphyrin monocarboxylic acid. G. B.

1440. Estimation of smallest oxygen, carbon monoxide, methane, and nitrogen content in purest ethylene by adsorption chromatography. (In German.) H. Pietsch. *Erdöl u. Kohle*, 1958, **11**, 157–9.—A detailed description is given of the illustrated apparatus and process for estimating traces of CO, O_2, N, and CH_4 together in purest C_2H_4 in one operation, by adsorption and chromatography on Linde mol sieve 5 Å. Components up to 1 ppm are estimated in *ca* 1 hr. R. T.

1441. Gas chromatographic analysis shows influence of fuel on composition of automotive engine exhaust. R. W. Hurn and T. C. Davis. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 353–72.—Research has shown that smog and other comparable atmospheric irritants can be produced from automobile exhaust. But automobile exhaust is a complex mixture; not all of the materials in it are important in the air pollution problem, and there is a possibility that only a relatively few cpds or classes of cpds are responsible for most of its irritant-producing qualities. This concept has not been proved, but the evidence supporting it is good enough to justify experimental work to learn how various factors affect the production of materials in automobile exhaust which are suspected of being active as smog-forming agents. The type of fuel burned by an engine affects exhaust composition in varying degrees depending upon engine condition, engine operation, and other unknown factors. The work which is reported was done to obtain factual data concerning: (1) chemical differences in the exhaust products from different fuels; (2) the effect of engine speed and load on these differences. Experimental data were obtained with the use of a late-model automotive V-8 engine on a dynamometer block. Fuels which were used included pure *iso*-octane, commercial LPG (butane and propane, separately), and seven gasoline stocks from different refining processes. Analytical data obtained by gas chromatography show that exhaust composition varies with engine speed and load according to consistent trends. These trends are influenced by fuel composition, and the degree of fuel influence depends upon mode of engine operation—some basic fuel characteristics are more heavily reflected in the exhaust than are others. Generally, differences in the composition of exhausts from different fuels are quantitatively small, but they are reproducible. These data cannot be construed as indicative that fuels do or do not differ in smog-forming potential. They outline compositional differences of interest to others who may wish to: (*a*) determine which components of the exhaust are important; (*b*) study measures which may be taken to make exhaust gas ineffective as a smog producer. (Authors' abstract.)

1442. A photometric titrator and method for the determination of bromine numbers with electrogenerated bromine. J. W. Miller, M. D. Grimes, and B. J. Heinrich. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 343–52.—A simple filter photometer, designed to detect the end point in titrations with electrogenerated bromine, has been applied to the determination of bromine numbers of petroleum products. The titration curves are automatically recorded by measuring the output voltage of an International Rectifier Corpn sun battery, which is employed as a detector. The light source is a General Electric mercury vapour lamp, and a monochromatic beam is obtained by use of a 365-mμ filter. The exact end point is obtained by extrapolation of two linear portions of the recorded curve to their point of intersection. The method is not based on an empirical end point procedure but on the fundamental principles of photometric titrations. Substitution reactions are minimized because of low bromine concn. A study has been made of the effect of the mercuric chloride ($HgCl_2$) cat on the bromine numbers of 17 pure olefins and a variety of petroleum products. The data indicate that the cat has little effect on the results, except in the case of Type I branched olefins (R, CH = CH_2) and cat cracked gasolines, when this coulophotometric procedure is employed. The presence of cat speeds up the bromine addition reaction and gives more satisfactory titration curves. The data show good precision. Duplicate determinations do not differ from the mean by more than 0·2 units at the lower limit to 3·0 units at the upper limit of the range 0·1–200 bromine numbers. The accuracy, in general, is $\pm 3\%$ relative. One person can analyse approx 20 samples for bromine number in 8 hr by this method. (Authors' abstract.)

1443. Performance of the Oldershaw column at reduced pressure. S. R. M. Ellis and R. M. Contractor. *J. Inst. Petrol.*, 1959, **45**, 147–52.—A modified Oldershaw perforated plate column is described and applied satisfactorily at pressures of 200–760 mm Hg to the two systems methyl*cyclo*hexane–toluene (foaming system) and ethylene dichloride–toluene (non-foaming system). The overall efficiency decreases at

reduced pressures, the order of the decrease being greater for a foaming positive system than for a non-foaming system.
A. D. S.

GAS

1444. Determination of gas yield of oils by catalytic cracking in presence of steam. (In German.) S. Schubert. *Erdöl u. Kohle*, 1958, **11**, 159–60.—Procedure is described for thermal cat cracking of oils in presence of steam to produce town gas. Exceptionally good results are obtained with Kogasin II and crude oil A, poor results with fuel oil S, tar from low-temp carbonization, and carburetting oil. Results are tabulated.
R. T.

1445. Developments in natural gas reservoir engineering. M. R. Tek. *Petrol. Engr*, March 1959, **31** (3), B47.—The proven reserves of natural gas have recently climbed to an all-time record of approx 247 trillion cu ft. The total net production of gas during 1957 alone was 11·5 trillion cu ft. The current high and still increasing costs of exploration, drilling, well completion, pipelining, processing, and distribution of natural gas point every day to urgent needs for more accurate and fundamental methods in gas production technology. Gas production engineering problems still lie in mathematics of gas flow through porous media. Use of finite difference mathematics and digital computing techniques provides the answer for specific problems. However, a complete partial differential equation explaining true flow phenomena has not yet been offered.
M. F. M.

ENGINE FUELS

1446. High octane ratings with tertiary-butyl acetate. R. S. Aries. *Petrol. Times*, 19.6.59, **63** (1614), 468.—A review of the more important methods currently in use for octane improvement (refining methods such as cat cracking and reforming and addition of TEL) is followed by an account of a new additive, tertiary-butyl acetate, announced by the Texas Co in the U.S.A.

This acetate is most effective with gasolines already having high octane values; the optimum dosage is 0·7% by vol, larger amounts do not increase the effect.

It is estimated that to upgrade 100 million brl of gasoline by 1·5 octane units would require investment of $350 million in additional refining plant, whereas a plant to produce 100,000 tons of tertiary-butyl acetate to similarly raise the ON would cost less than $20 million.
G. A. C.

1447. Accurate determination of sediment in petroleum fuels in the parts-per-million range. F. A. Buehler, J. P. Kirchner, and J. S. Wiberley. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 338–42.—Methods have been studied for determining traces of sediment in light petroleum products. A new method is proposed which is believed to be more accurate than other published procedures for determining sediment in the ppm range. The novel feature of the new method is the use of glass-fibre filter disks for filtering the fuel. This type of filter is superior to sintered glass or asbestos in that it minimizes the blank caused by adsorption of soluble fuel elements. The method is also rapid and convenient for routine operation.
(Authors' abstract.)

1448. High octane components from catalytic reformates. S. C. Samuels, G. C. Ray, and A. D. Reichle. *Industr. Engng Chem.*, Jan 1959, **51** (1), 73.—Cat reforming has played a major role in raising the octane rating of naphthas to the level required for current motor fuels. The process is less attractive at high levels because of rapid decrease in yield. Fractionation, solvent extraction, selective adsorption, and selective cracking can be used to produce high octane components from cat reformates. Simple dist produces substantial yields of high boiling fractions with leaded Research octane rating as high as 106. Solvent extraction may be used to concentrate the aromatics. Adsorption improves the octane rating by removing low octane *n*-paraffins. Selective thermal cracking upgrades octane rating by converting *n*-paraffins to low boiling olefins and by concentrating high octane aromatics.

These light olefins can be used as alkylation feed to make additional high octane components.
M. F. M.

1449. Power fuel and motor. (In German.) H. Hoffmann. *Erdöl u. Kohle*, 1958, **11**, 81–6. Pt 1. Power fuel and diesel motor.—Traces of V in diesel fuels existing as a V-porphyrin complex cause severe scaling of the burner and ante-chamber lower parts. In developing a multi-fuel motor by operating an unmodified diesel motor with leaded gasoline, strong erosion of the burners caused by Pb in the gasoline was observed. Among the advantages of the multi-fuel motor—which can be described only as a "crisis-type"—are use of cheap diesel fuels and economy of fuel consumption, valuable assets for military considerations. Possible ways of making the diesel engine fuel-insensitive are discussed. The fuel preparation in the ante-chamber gives favourable assumptions for ignition beginning and rest combustion of the total charge, in spite of this the motor with diesel fuel is not knock-free. In the same motor Mogas (army fuel) gives a steep pressure rise and knock damage on the piston base. Detonation and knock damage can be removed by increasing the compression end temp, thus shortening ignition lag. In times of crisis a true multi-fuel motor gives the same performance as with diesel fuel, without limiting the ON, without perceptible change in combustion noise, with all carburettor fuels, even with high aromatic-containing fuels, with jet fuels, and with lub oils. There are motors now which—with American proprietary fuels—after two hours idling, show, within 12 or 10 sec, 95% of the full load and full rev.
R. T.

1450. Effects of engine-operating variables on the composition of automotive exhaust gases. J. M. Chandler. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 324–35.—Data are presented on the effects of engine variables on the concn of two automotive exhaust gas constituents—hydrocarbons and oxides of nitrogen. These data were obtained by the participating lab of the Variables Panel of the CRC Motor Group on the Composition of Exhaust Gases. The tests for the two types of constituents were not run concurrently because of differences in sampling and analysis techniques, and therefore they are reported in separate sections. The factors affecting hydrocarbon concn in exhaust gas to the greatest extent are manifold vacuum, engine de-tuning (maladjustment and/or poor mechanical condition), and cold as compared to hot engine starting. Manifold vacuum of more than approx 21·5 inches Hg (mercury) accounts for high concn of hydrocarbons during deceleration. This effect is accentuated by high speeds at the start of deceleration and by manual transmissions as compared to automatic transmissions. Accelerating and cruising conditions at various engine speeds produce similar hydrocarbon concn, generally in the range of 1–5% of the supplied fuel, with the hydrocarbon concn tending to decrease with increasing engine speed. Enriched carburettor idle settings increase hydrocarbon emission during cruise up to approx 30 mph. Spark-plug condition is of great importance. One misfiring plug may more than double the average hydrocarbon concn. A deposit-fouled spark-plug set can increase the rate of hydrocarbon emission more than 2½ times during a wide-open throttle acceleration. In general, the average hydrocarbon concn for cruise and idle as reported by the Field Survey Panel are higher than the average levels of hydrocarbon concn reported herein. Further studies are in progress

to resolve these differences. Among variables which affect oxides of nitrogen, air–fuel ratio is of primary importance. Lean mixtures promote the formations of oxides of nitrogen and increase the relative effects of other engine variables. Under full throttle, rich mixture conditions, concn of oxides of nitrogen are relatively low. Under part-throttle conditions, however, mixtures are sufficiently lean to permit varying degrees of importance to be attached to ignition timing advance, manifold pressure increase, and C.R. increase, all of which promote oxides of nitrogen formation. Under road-load cruise conditions and during full-throttle accelerations, higher speeds produce higher concn. During part-throttle accelerations, there is no general effect of speed, and high concn may be exhausted even at low speeds. During idling and deceleration, oxides of nitrogen concn are so low as to be considered insignificant. The trends of oxides of nitrogen concn established by lab data were confirmed by the results of the 1956 field survey. (Author's abstract.)

1451. Determination of knock resistance of carburettor fuels in the BASF test motor. (In German.) W. Wolf. *Erdöl u. Kohle*, 1958, **11**, 161–3.—Principle and construction of the present BA8F motor for testing knock resistance of carburettor fuels, which replaces the former IG motor, are described. The test aggregate consists of a water-cooled, one-cyl, four-stroke cycle motor with C.R. changeable during operation and all relevant accessories. Its sensitivity both by the motor and research methods is improved. Also ON >100 can be measured. Ring tests with the BASF motor made every six months agree among themselves and with those of the CFR participating motors. R. T.

1452. The pumpability of aviation turbine fuels at low temperatures. H. Strawson. *J. Inst. Petrol.*, 1959, **45**, 129–37.—In turbine-powered aircraft a fuel can be handled satisfactorily up to the point when partial solidification prevents adequate flow within the fuel tank itself. The controlling fuel property is neither the fp (IP Cold Test) nor the visc, but the yield value which the semi-solid fuel develops. Existing turbine fuel spec designed to ensure adequate low temp performance are not directly related to the problem, and a need for an improved spec test for pumpability is emphasized. Such a method is proposed and has been evaluated on a range of different fuels. Results show that it possesses good repeatability and reproducibility and is suitable for control use. The use of an additive to improve pumpability is considered, and some results are quoted to show that this approach has some promise. A. D. S.

SPECIAL HYDROCARBON PRODUCTS

1453. Solubility of SF_6, C_2F_6, and N_2 in transformer oil. N. Vanderkooi. *Amer. Inst. Elect. Engrs*, 1959, Paper No. CP 59–258, 6 pp.—Sol (ml gas/ml oil) measured (expt details, diag) at atm pressure, 27°–80° C, in uninhibited transformer oil (Esso Univolt 35, d_{20} 0·884). SF_6 0·43/27° C, 0·30/70° C; C_2F_6 0·39/27° C, 0·24/80° C; N_2 0·073/27° C, 0·076/70° C. Temp/sol equations are given. V. B.

DERIVED CHEMICAL PRODUCTS

1454. Present position of petrochemistry. (In German.) F. Zobel. *Erdöl u. Kohle*, 1958, **11**, 76–81, 164–8. Pt 1. Saturated hydrocarbons. Pt 2. Unsaturated hydrocarbons.—Pt 1 deals with oxidn, hydrogenation, chlorination, nitration, and sulphurization of saturated hydrocarbons. Basic information is presented with supporting schemes, on the course of the reactions based on CH_4. The effect of reaction variables, temp, pressure, cat, etc., is discussed. Other hydrocarbons mentioned are C_2H_6, C_3H_8, and C_4H_{10}. Economy of industrial applications is discussed, and participating firms—chiefly in the U.S.A.—with their sp products are mentioned. Quant development of petrochemistry in the U.S.A. from 1930 to 1955 is given in a chart. 47 refs.

Pt 2 deals with hydration, chlorination, alkylation (the Oxo reaction), polymerization, and oxidn of unsaturated hydrocarbons C_2H_4, C_3H_6, C_4H_8. The more important processes—with schemes of the reactions—are described. Firms participating in the manufacture of sp products are mentioned. The effect of reaction variables, temp, pressure, cat, etc., upon product yields and distribution is illustrated. The petrochemical reactions of CH_4, C_2H_4, and C_3H_6 are grouped in a summarized scheme. 31 refs. R. T.

1455. Estimate petrochemical properties. R. Nokay. *Chem. Engng*, 1959, **66** (4), 147.—Parachor, critical temp, bp, and sp gr are important properties of hydrocarbons, and their interrelationships have been extensively studied. In many places, however, no data are available, but there are empirical equations that help to estimate properties of pure hydrocarbons. These equations, which are limited to hydrocarbons with normal bp between 400° and 1400° R and sp gr between 0·5 and 1·0 are: (1) $\log [P] = -3{\cdot}31 + 2{\cdot}08599 \log (T_{10}/\text{sp gr}^{0{\cdot}5879})$; (2) $\log [P] = -4{\cdot}20895 + 2{\cdot}29319 \log (T_1/\text{sp gr}^{0{\cdot}5937})$; (3) $\log [P] = -8{\cdot}93275 + 3{\cdot}68894 \log (T_c/\text{sp gr}^{0{\cdot}6676})$; (4) $\log T_1 = 2{\cdot}451 + 0{\cdot}05901 \log \text{sp gr} + 0{\cdot}90965 \log T_{10}$; (5) $\log \text{sp gr} = -6{\cdot}59654 + 16{\cdot}946 \log T_1 - 15{\cdot}415 \log T_{10}$; (6) $\log T_c = 19{\cdot}078 + 0{\cdot}2985 \log \text{sp gr} + 0{\cdot}62164 \log T_1$; (7) $\log T_c = -0{\cdot}68893 + 5{\cdot}68002 \log T_1 - 4{\cdot}60138 \log T_{10}$, where $[P]$ is parachor, T_1 bp at one atm pressure in degrees Rankine, T_{10} bp at 10 mm Hg pressure in degrees Rankine, and T_c critical temp. M. F. M.

COAL, SHALE, AND PEAT

1456. Alicyclicity and smoke emission of coal. B. K. Mazumdar, S. S. Choudhury, and A. Lahiri. *Nature, Lond.*, 1959, **183**, 1613.—Various coals were dehydrogenated with sulphur below the decomp point of the coal. When the samples were combusted under controlled conditions the smokiness (defined as the wt of soot particles trapped by glass wool from the flue gas) was found to be a linear function of the % of alicyclic carbon in the coal. The effect could also be obtained by halogenating the coal, or treating it with sulphuric acid, phosphoric acid, phosphorus pentoxide, or potassium hydrogen sulphate. H. C. E.

1457. Shale oil activities. R. J. Cameron and R. E. Gustafson. *World Petrol.*, March 1959, **30** (3), 66.—Oil shale activities in the U.S.A. and elsewhere in 1958 are described, the most important development being the proposed nuclear test explosion in the oil shale of W Colorado with the aim of shattering and retorting the shale *in situ*; in theory this would eliminate most of the high production costs involved in oil shale mining or retorting. In general, research and pilot-plant activities are lagging in the U.S.A., but in foreign areas there have been some active developments. In Brazil a gas-combustion retort has been worked successfully on a pilot scale. Commercial designs have now been made. In Estonia a new 10,000-bd plant is being built at Kochtla Jarwe. In Sweden experiments are being carried out on *in situ* retorting using electrical heaters, and there has been a 50% increase in capacity of the Kvarntorp plant. A plant is to be built in Thailand with a capacity of 600 bd. C. A. F.

MISCELLANEOUS PRODUCTS

1458. High purity aromatics from coke-oven oil (process flow sheet). C. S. Cronan. *Chem. Engng*, 1959, **66** (1), 110.—The first plant of its kind to start up in the U.S.A., Jones and Laughlin Steel Corpn's coal chemicals aromatics unit at

Aliquippa, Pennsylvania, represents the fruits of continuing effort to improve the quality of coal chemicals for the requirements of the chemical process industries. In operation since Aug 1957, J and L's plant has been turning out high-purity aromatics from crude coke-oven light oils. Capacity is 55,000 gpd of a mixture of toluene (70%), benzine (20%), and xylene (10%). The paper gives the description, the flow sheet, and some pictures of the plant. M. F. M.

CORROSION

1459. Synthetic pipeline coatings promising. M. J. Dabney *et al.* *Oil Gas J.*, 8.6.59, **57** (24), 161.—Study of epoxy and/or epoxy bituminous combination, and on polyethylene and vinyl tapes for improved pipe coatings has shown that selected thin film synthetic coatings meet requirements and are competitive with conventional materials. Optimum cure must be used, and formulation takes account of both cathodic and general corrosion resistance. New application and curing methods may be necessary to make the thin film synthetic coatings competitive, a flame-curing technique being promising.

Lab investigations to determine deficiency of the synthetic coatings include use of an impressed voltage across a test film higher than is necessary for cathodic protection.

Tables show electrolytic cell test results with various products, test summary, and typical electrical property observations. G. A. C.

1460. Corrosion inhibitors in automotive coolants. M. Levy. *Industr. Engng Chem.*, Feb 1959, **51** (2), 209.—This work was undertaken to obtain data on the action of inhibitors on metals in an automotive cooling system in ethylene glycol media and to develop an accelerated corrosion test for evaluating these inhibitors.

Materials shown by polarization tests to be either anodic or cathodic inhibitors for local action corrosion of steel, copper, or solder operated 2000 hr in simulated vehicle cooling system and should prove satisfactory in field service. Current flow data indicated the relative efficacy of various inhibitors for reducing galvanic attack on steel and solder.

Local action corrosion currents were determined utilizing the polarization technique with externally applied emf in contrast to tedious methods used previously. This technique provides a means for further verification of the electrochemical theory of corrosion and its possible limitations. M. F. M.

1461. Corrosion inhibitors and their special application. (In German.) K-H. List. *Erdöl u. Kohle*, 1958, **11**, 86–8.—Choice and testing of corrosion inhibitors—useful in the petroleum industry—are discussed. Theories relating to their functions are explained under physical inhibitors, which adhere to the surface, and chem inhibitors, which effect passivity. Practical corrosion problems—especially in the petroleum industry—concerning inhibitors against acid and salt attack as in borehole treatment, for oil and water mixtures in gas production wells, for corrosive crude oil with diminishing moisture in storage tanks, etc., are discussed. R. T.

1462. Correlate corrosion testing methods. R. V. Jelinek. *Chem. Engng*, 1959, **66** (2), 105.—Corrosion test objectives usually include: (1) study of the corrosion mechanism and the factors that influence it; (2) selection of best material or protective coating which withstands the particular corrosive environment; (3) development of materials for particular uses; (4) study of the effectiveness of various protective measures; and (5) control of product uniformity in the manufacture of corrosion-resistant materials. Common methods for evaluating corrosion effects include visual and microscopic observations, wt change, physical property change, electrical resistance change, hydrogen evolution, oxygen absorption, and anode and cathode polarization, etc.

Corrosion test objectives and the application, advantages, and limitations of various methods of evaluating corrosion effects are described in the paper. M. F. M.

1463. New urethane coatings tops in resistance. R. B. Norden. *Chem. Engng*, 1959, **66** (3), 144.—Urethanes are the latest developments in protective coating, and might become a definite threat to established synthetics, such as vinyls and epoxies, as a protective covering of chemical equipment.

Developed in Germany during world war II, urethane coatings appear to have a very good chemical resistance (this is shown by comparing the resistance of urethane with epoxy and vinyl cpds), and they have excellent abrasion resistance and hardness properties. A number of chemical and petroleum companies in the U.S.A. have the urethane coating under plant evaluation, and the results of the programme are just coming in. It is shown that coated concrete floors are holding up particularly well in chemical and wear service, and coated solvent tanks and chemical reactors all look good. The paper describes how urethane coating can be applied to various surfaces. M. F. M.

1464. Fighting corrosion in the desert. F. M. Maasry. *Oil Gas J.*, 15.6.59, **57** (25), 124.—The above-ground section of the Trans-Arabian pipeline lies entirely in Saudi Arabia, and there are hundreds of buried sections at various points along its length ranging from 30-ft camel crossings to stretches of several miles in low areas. These latter are subject to various soils ranging from those of dry desert to clays and loams, resistivities being from hundreds of thousands ohm-cm to 800 ohm-cm, thus protection is difficult. All such sections were given normal asphalt coating, and in rocky areas heavy asbestos felt rock shield was also used.

Failure occurred due to drying soil pulling off the asphaltic coating, uneven application of spray, and inadequate bonding between pipe and coating.

When the line was laid in 1950, cathodic protection was applied, rectifiers being installed in the four pump stations and in the Sidon terminal, and magnesium anodes on the intermediate sections. Diesel-driven generators supplied necessary power, at *ca* 11-mile spacings for the continuously buried section of 245 miles. At first generators could only run a limited time, less than four days contemplated due to lubrication difficulties. New engines now in operation run on crude oil from line and ensure 90% time operation of cathodic protection station. The short buried sections were found to be inadequately protected by magnesium anodes, corrosion leaks occurring, necessitating renewal of faulty pipe.

Trouble at pump stations was found to be due to insufficient current, supplementary rectifiers were necessary. The submarine system was protected by four 20-V, 250-amp rectifiers connected to steel rail anodes which lasted three years, but new protection consists of lead alloy in cable form. G. A. C.

1465. Is cathodic protection for you? R. B. Norden. *Chem. Engng*, 1959, **66** (1), 154.—There is increasing evidence that cathodic protection at Dow Chemical Co's Texas division is paying off in a big way. There have been only three leaks in the underground piping per year since the cathodic protection programme was fully organized for underground protection. Many new practices have also proved successful in protecting sea water screens, large dia pipes, heat exchangers, and other equipment. In all cases Dow used magnesium anodes, rather than applied current anodes, and the reason for this and a brief description of the installations protected by cathodic protection method is given in the paper. M. F. M.

1466. Automation in cathodic protection. R. Girotti *et al.* *Oil Gas J.*, 20.7.59, **57** (30), 73.—Gas pipelines in Italy cross densely populated and highly industrialized areas with a great many dc rail and tramways which cause electrical fields in the soil with resultant corrosion of buried pipelines.

Company-owned telephone cables are used as transmission lines, buried along the gas-line axis, and a telemetering and remote control system was installed to control electrical state and flow conditions of the line routed mainly in mountainous areas difficult of access in winter.

When pipeline primary constants are known, computation of attenuation, phase constants, and characteristic impedance is theoretically possible using conventional line formulæ. But experimentation is necessary because pipelines have a relatively high dispersion conductance concentrated in many points, also calculation of line inductance is difficult.

Owing to sharp line attenuation, data must be transmitted through amplifiers, and the circuits which are illustrated are those usually employed in digital electronics.

Line attenuation, in general, is drawback limiting application to short distances, unless equipment to overcome this problem is provided. G. A. C.

1467. Novel designs tame tough corrosives. L. S. Simons. *Chem. Engng*, 1959, **66** (2), 130.—Design of Freeport Sulphur's 50 million lb pa nickel plant at Moa Bay, Cuba, is about completed, and the plant should be on stream in the summer of 1959. The focal point of operation is the leaching system, where thickened ore pulp (35% solids) is preheated with low pressure steam and then pumped to leaching reactors. The reactor design calls for injecting high pressure steam and agitation, then adding 98% H_2SO_4. Leaching is carried out at 400°–500° F and 500 psi. Further processing involves neutralizing sulphate liquor containing nickel and cobalt, then precipitating the two metals with hydrogen sulphide.

The most severe problems in the plant are concerned with materials of construction. Nickel alloys do not survive in above conditions. Titanium is suitable for reactor construction, but it is too expensive. Solution to the problem has been found by fabricating the reactors from a system comprising a lead-lined sheet of steel, acid-proof brick, and carbon brick. The paper describes the intricate points of design and construction, such as bonding tricks and installation techniques employed. M. F. M.

1468. New plastic bridges temp gap. R. B. Norden. *Chem. Engng*, 1959, **66** (6), 194.—Hercules Powder's new chlorinated polyether (polybischloromethyl oxetone) plastic, named Penton, with a mol wt of *ca* 300,000, has the following properties which make it particularly interesting to chemical engineers: (1) it can be easily moulded to close tolerances on standard injection and extrusion equipment; (2) in chemical resistance it is almost as good as Kel-F and Teflon; and (3) it can withstand temp of almost 250° F, or nearly 100° higher than usual thermoplastics. A typical application is Penton-lined diaphragm valve in a pipeline commonly using porcelain valves. This line refluxes carbon tetrachloride of 176° F. The carbon tetrachloride is saturated with HCl and wet chlorine. Penton is functioning satisfactorily here without any sign of failure.

The paper gives a table of comparison between corrosion resisting properties of Penton with PVC and other plastics, for acids, alkalis, and solvents. M. F. M.

1469. Sulphide scaling under hydro-refining conditions. 2. W. H. Sharp and E. W. Haycock. *Oil Gas J.*, 15.6.59, **57** (25), 99.—The chief variables influencing corrosion rate are temp and partial pressure of the H_2S and composition of steel. Reduction of sulphiding rates of low-chromium steels occurs when hydrocarbons are added to the H_2S/S feeds under simulated hydrosulphurizer conditions.

Organic sulphides cause scaling problems in change heaters, and data were obtained by substituting an equivalent amount for H_2S.

Tables show effect of hydrocarbon on sulphiding rates under simulated hydrosulphurizer and platformer conditions, analyses of refinery sulphide scales, and corrosion of ferrous alloys exposed to organic sulphides, which data indicate extent of conversion of typical sulphides and thus expected degree of corrosion. G. A. C.

1470. Corrosion in amine type gas processing unit. R. A. Graff. *Petrol. Engr*, March 1959, **31** (3), C12.—Widespread use of amine gas treating process for removal of H_2S and CO_2 from gas streams has resulted in several hundred plant installations, using a 15–30% soln of monoethanolamine at ambient temp and elevated pressures. The soln is regenerated by boiling at reduced pressures at temp between 230° and 280° F. The hot MEA soln heat exchanger unit, soln stripper, and soln reboiler are most susceptible to attack and corrosion difficulties. Corrosion rates are highest at points of extreme turbulence or high metal stress. An additional type of MEA soln corrosion occurs when impurities are present in the MEA soln. In some cases, at points of high soln turbulence such as solution pressure let down valves, a combination of corrosion and erosion also takes place. The answer to this is the avoidance of high velocities, especially at points of soln entry into vessels, reboilers, exchangers, etc.

Corrosion of amine plants can be minimized with the following design considerations: (1) moderate acid gas loading of the soln; (2) minimum operating speeds for pumps; (3) low operating temp for the soln strippers; (4) low velocities in soln and vapour transfer lines; (5) oversized reboilers; (6) elimination of points of turbulence; and (7) elimination of all solids as well as oxygen from the soln system. M. F. M.

1471. Formation of deposits and external corrosion in steam generators. (In Italian.) F. Mastrorazio. *Riv. Combust.*, 1959, **13** (5), 347–63.—After some considerations on the quality and preparation of heavy fuel oils, the paper briefly examines the causes and mechanism which determine and control scale deposits and external corrosion in oil-fired steam generators in both the high and low temp areas, a type of deterioration which may impair generation efficiency. Deposits and corrosion in the high temp areas may essentially be ascribed to the fuel ash components, while problems in connexion with the low temp areas are mainly caused by the presence of sulphur. The various ways and means studied to attenuate the consequences of these sources of trouble, such as design expedients, the use of corrosion-proof materials, operation and maintenance expedients, the use of additives, and the like are quickly reviewed from the angle of efficiency, advantages, and possible applications. It is economic considerations in the long run that turn the scale in the choice of the most suitable equipment and systems for a given application. No general rule can be laid down covering every case: each application calls for a special study with due regard for, and appraisal of, the characteristic features of such application (type, specification, and service conditions of the generator; type, consumption, and cost of fuel; cost of labour and materials; whether the generator is being designed or already in service, etc.). Nevertheless, against the present background of knowledge and pending more thorough, extensive experience, some general guiding considerations are offered. (Author's abstract.)

1472. Experience in combating corrosion on the low temperature surfaces of boilers. (In Italian.) A. Grondona and G. P. Marcucci. *Riv. Combust.*, 1959, **13** (5), 364–78.—The authors deal with the problem of corrosion, engendered by the presence of sulphur in fuel oils, on the low temp surfaces of

boilers. The various ways to solve this outstanding problem from the construction angle (cold air by-pass, hot air recirculation, gas recirculation, combined stream of gas and air) are examined and the results reported of actual tests with various additives (ammonia, lime, dolomite, pyridine, magnesium oxide). A broad review is given of results achieved in 25 electric power plants throughout the world, and details submitted of tests made at the Marchwood power station, Great Britain. The authors conclude by pointing out that the problem can be narrowed down to acceptable limits by constructional expedients, but that this entails lower efficiency, or resorting to additives that will lower the dew point of the fumes. Dolomite has proved itself one of the most efficient additives. (Authors' abstract.)

SAFETY PRECAUTIONS

1473. Designing electrical installations in explosion-endangered plants. (In German.) J. Bleck. *Erdöl u. Kohle*, 1958, **11**, 177–82.—Brief ref is made to official regulations. Problems accompanying risks from elec equipment in potentially explosive atm, *e.g.* containing gases, vapours, and dusts, are reviewed. Wherever possible elec equipment should be placed outside danger zones. Distance of switch and control gear will be governed by convenience and economy. Choice, proportioning, and protection of elec operating means are discussed with illustrations of sp plant items. R. T.

1474. Danger range of explosion-endangered industrial places, choice of safeguards, maintenance of explosion-safety in the plant. (In German.) K. Czemper. *Erdöl u. Kohle*, 1958, **11**, 173–7.—A review of problems, and available safety measures, arising from explosive gas, vapour, cloud, or dust mixtures in industry. Important properties discussed are explosion pt, fl pt, and explosion range. In refinery operations zones occur which are an explosion danger in normal operation, *e.g.* evacuation of tanks containing liq, and the air space inside tanks with floating roofs and outflow openings. Regions occur also in which danger arises only when something goes wrong, *e.g.* joint failure. Dangers are common to lab and works, and safety measures, in particular adequate ventilation and safe elec motor installation, are discussed. R. T.

1475. Explosion-protected switches. (In German.) R. Dehrmann. *Erdöl u. Kohle*, 1958, **11**, 99–104.—In large chem installations, oil refineries, etc., danger of explosions from faulty switches is always present, particularly from fire damp in mines. The author discusses safety measures in this profusely illustrated article. R. T.

ECONOMICS AND MARKETING

1476. 1958 and its implications for the oil industry. P. H. Frankel. *Inst. Petrol. Rev.*, 1959, **13**, 173–6.—Overall energy consumption in Europe has been increasing during the last three years at a much slower rate than was anticipated by the experts. This recession is being borne entirely by coal, the petroleum energy sources being very buoyant. The economics and significance of these factors are considered. The two important events of 1958 concerning international oil supplies, namely, the advent of actual and potential newcomers to the ranks of suppliers of Venezuelan or Eastern Hemisphere crude oil and the imposition of official oil import restrictions in the U.S.A. are discussed. It is felt that there will be an increasing incidence of governmental influence on the structure of international oil. Finally, the influence on the location of refineries of cheaper transport costs of crude oil due to the use of larger tankers and large dia pipelines, and market requirements for residual fuel oil is considered. A. D. S.

1477. Sulphur's world supply pattern changes. D. R. Cannon. *Chem. Engng*, 1959, **66** (6), 104.—In little more than three years the sulphur industry, once one of the world's most stable industries, with well ordered supply lines, has been transformed into a business with a very competitive future. New production is shaping up where little existed before, and the swelling flow of crude oil to Europe and tightening pollution control measures everywhere means more sulphur recovery by refineries. The demand for sulphur is also increasing, and a world need for 500,000 tons more sulphur this year is estimated.

The paper gives up-to-date information on sulphur production in a number of countries, including France, Japan, Mexico, Brazil, and Canada. There is a tremendous sulphur potential in Canada and France (*e.g.* the latter is estimated to have 70 million tons of sulphur locked in the Lacq natural gas deposits). The paper draws a gloomy picture for U.S. sulphur industry. M. F. M.

1478. Oil's recovery spawns chemical feedstocks. J. B. Bacon. *Chem. Engng*, 1959, **66** (5), 90.—This paper is a statistical survey of oil and gas production and also of present trends in refinery processing and yield patterns. Some trends, it is shown, will give increased yield of potential petrochemical feedstocks, while others will compete strongly for these potential feedstocks. For example, more cat cracking and reforming will bring a sizeable boost in C_3's and C_4's, prime chemical raw materials. But trends in polymer-gasoline process and alkylation will use up a lot of this. Oil industry's broad picture is reviewed and economic forecasts made for present and future. M. F. M.

MISCELLANEOUS

1479. The first oil well. P. A. Dickey. *J. Petrol. Tech.*, Jan 1959, **11** (1), 14–26.—In the 1850's means were already known for refining oil obtained from a variety of sources for illumination and lubrication. Mineral oil from seeps was known and used. In the Ohio River area there was a considerable salt industry. Drilling for brines had been carried out, using cable tool methods. Oil had been obtained with brine, and finally a company was formed to obtain oil by drilling. In 1857 E. L. Drake went to Titusville to start operations for the company. First oil springs were opened up, and then drilling began by a salt-well driller, W. A. Smith, in 1859. Oil was found at the unexpectedly shallow depth of 69 ft. This well gave *ca* 10 bd. Much leasing and drilling then began. The overall activity involved teamsters, coopers, speculators, and others. Three other wells were completed in 1859, and at the end of 1860 there were 74 producers. Flowing wells were

obtained in 1861, and the large output caused the price of oil to drop from $1.25/gal to $0.25/gal.

Drake did not take full advantage of the discovery, and after moderate success traded in oil stocks, lost money, suffered ill-health, received a pension, and died in 1880.

G. D. H.

1480. U.S.S.R. hits highest oil production. Anon. *Petrol. Engr*, March 1959, **31** (3), E4.—U.S.S.R. oil output climbed to a record 2,270,000 bd in 1957, a 14% increase. But Russian officials complain that still greater production should have been possible.

In Bashkiria area, between the Ural mountains and Volga river, 109 wells completed during the past six years are not yet producing because they have not been connected to pipelines. The Soviet Union planned a $1 billion expenditure on expansion in 1958, a figure which compares favourably with U.S. private investment. M. F. M.

1481. Optimum structure of petroleum refining industry and of product transport. G. Fournier and E. Ventura. *Ann. mines*, 1958, 708–82; (abridged) *Bull. Ass. franç. Tech. Petrole*, 1959, 445–67.—Problem was 1965 location of new refineries (and/or extensions to existing refineries), coupled with pipeline product transport on basis of forecast consumption of various areas of France and also adjoining areas of Switzerland and Germany. Formulation of programme is described in detail and computer-arrived solutions are discussed. Study based on producing gasoline and three grades of fuel, derived from choice of four crudes (Middle East and Sahara). Favoured solutions are large new refinery at Strassburg pipeline fed from Mediterranean or slightly smaller refinery at Strassburg with refined product pipeline distribution from Mediterranean to Chalon. V. B.

1482. Steric effects in aromatic amine anti-knocks. J. A. Brennan, J. J. Giammaria, and E. A. Oberright. *Industr. Engng Chem.*, Jan 1959, **51** (1), 77.—Variations in anti-knock activity of aromatic amines have been explained by steric hindrance. Steric effects were demonstrated with Py-tetrahydroquinoline and suitable methyl derivatives. Increased hindrance of the hydrogen on nitrogen by the alkyl group caused a marked reduction in anti-knock activity. The least hindered cpd, 6-methyl-Py-tetrahydroquinoline, was the best. The most hindered, 2,2,4-trimethyl-Py-tetrahydroquinoline, was the poorest anti-knock.

Steric hindrance of the amine function by alkyl groups was also used to explain decreasing anti-knock activity in the series N-methyl-, N-ethyl, N, *n*-propyl-, and N-*n*-butylaniline. The ortho effect, which results in decreased activity in aromatic amines, has also been explained on this basis.

M. F. M.

1483. From oil to chemicals. C. E. Morrell, Jr. *Industr. Engng Chem.*, March 1959, **51** (3), 247.—The petrochemicals industry is exerting a profound impact on basic chemical technology. One of the most important conversion processes is cracking, the backbone of hydrocarbon intermediate production. Removal of hydrogen from hydrocarbons at high temp and in the presence of cat is also important. Cat reforming, polymerization, and oxidn are also widely used, and these are briefly touched upon in the paper. M. F. M.

1484. Corrosion and soot emission in oil-fired heat plants with reference to the formation of SO_3. (In Italian.) G. F. I. Murray. *Riv. Combust.*, 1959, **13** (5), 319–46.—Low temp corrosion phenomena occurring in oil-fired heat plants are influenced by a number of factors, such as certain fuel oil constituents and operating conditions. Corrosion can be contained within certain limits by appropriate plant design, combustion control, and the use of additives. With regard to the latter, some interesting plant tests are described.

(Author's abstract.)

1485. Research and development—the catalyst for steel and petroleum progress. C. L. Huston, Jr. *Proc. Amer. Petrol. Inst.*, 1958, **38** (3), 258–64.—This paper discusses certain problems relative to the development of better steel plate materials for the petroleum industry. Steel research has been criticized for being too concerned with its own processes and not concerned enough with those of its customers. This criticism may once have been warranted to some extent. But now under study are these problems of interest to petroleum: developing better weldability in the A-387 chrome moly steels; production and forming techniques for Hastelloys B, C, and F and titanium in clad steel form; the value of ultrasonic testing as an inspection tool; the effects of hydrogen on the metallurgical properties of clad and alloy steels. Standard steel specifications may need more prompt and more frequent modification in the future to meet individual customer requirements and permit more rapid development and acceptance of new materials. Every new product must demonstrate potential economic justification in both its market application and its manufacture to merit continuing development. Quenched and tempered plate is an example. Continued and improved co-operation between steel and petroleum will result in better steel research to meet petroleum's needs. (Author's abstract.)

BOOK REVIEWS

Handbook of Natural Gas Engineering. Donald L. Katz, David Cornell, John A. Vary, Riki Kobayashi, Jack R. Elerbaas, Fred W. Poettmann, and Charles F. Weinang. New York, Toronto, London: McGraw-Hill, 1959. Pp. vii + 802. £14 10*s*. 6*d*.

Compared with the other applied sciences, there is a marked paucity of reference books of a composite character dealing with petroleum production engineering which provide in comprehensive form the information required by practising engineers. The "Handbook of Natural Gas Engineering," published recently as one of a series dealing with chemical engineering, is welcomed, not only because it fills a long-recognized void in the sphere of natural gas engineering, but also because it will be a useful reference volume for petroleum production engineers, dealing, as it does, with the application of physics to many problems arising in both natural gas and petroleum production.

From the academic standpoint the Handbook will sustain interest for the student not as yet affected by the motivation of interest in practice, because much of the theoretical treatment is illustrated by practical examples, together with pertinent quantitative data. For the practising engineer in this particular field the handbook is a wide store of information, gleaned largely from the technical literature, the references to which—while confined mainly to publications in the U.S.A.—are extensive and are an important contribution in themselves.

Geology and associated subjects are disposed of, perhaps too briefly, in the introduction. While the book is one of a series dealing with chemical engineering, this brevity in dealing with these important subjects and the level of the treatment detracts somewhat from the stature of an otherwise admirable volume.

As one would naturally expect, very considerable space is devoted to phase and volumetric relationships and to the

properties of hydrocarbons and of complex mixtures in single- and two-phase regimes, particularly in the gaseous phase. The subject is covered thoroughly and extensively, together with examples, which indicate the practical application of the described theory. Chapter V is an important contribution, dealing in detail with water–hydrocarbon systems, and discussing the physiochemical behaviour of such systems in relationship to limitation of moisture content for prevention of the formation of gas hydrates. Flow and compression in gas systems are adequately discussed for transportation and for vertical flow from gas and oil wells, together with practical examples. Control of flowing well-head pressure is dealt with only indirectly, and the theory of two-phase flow through nozzles is omitted.

Admittedly the handbook is very comprehensive and voluminous, and one is consequently reluctant to criticize the relative space devoted to the various topics involved in natural gas engineering. Some topics, such as drilling and geology, are inevitably treated with greater brevity for exploitation than for development of producing reservoirs —a bias to be expected in this case.

The theory relating to single-phase flow of fluid through porous media in stabilized and unsteady states is treated clearly and concisely in Chapter X, together with methods of solution. The same compliment can be paid to the discussion in the following chapters of development and operation of gas fields and of gas from condensate and oilfields.

There is a fund of valuable information in Chapter XIII, together with detailed exposition of the methods employed for the selection and design of equipment employed in multi-stage separation and dehydration of gas and oil, in gas sweetening, and gasoline extraction from field gases, while the fundamentals of fractional distillation and discussion of the design calculations involved in stage processing are logically and admirably treated in Chapter XIV.

The construction, design, and selection of pipeline transportation systems, of gas compressor plant, and of ancillary equipment is treated in Chapter XVII. The changes in concept of design of such systems, consequent to the enormous expansion of the natural gas market in the past decade, are summarized in interesting reading. One of the major associated problems in transmission of fuel gas being gas storage to offset fluctuation in demand, particularly of the seasonal type, this subject is discussed in relationship to natural gas fuel requirements in the North American continent. The utilization of underground storage reservoirs for this purpose is described in all its aspects, including the economic, technical, and many other problems arising in ventures of this kind.

This book is welcomed as a valuable addition to the small existing library of reference volumes dealing with natural gas and oilfield engineering and also as a book, which, in the same capacity, will be of considerable value to chemical engineers whose professional interests are linked with petroleum production and refining. F. H. G.

Seventh Symposium (International) on Combustion. The Combustion Institute. London: Butterworths Scientific Publications, 1958. Pp. xlvi + 959. £11 4*s*. 0*d*.

The Seventh International Combustion Symposium was the first one to be held in Great Britain. The excellence of the papers and of their presentation in this symposium, as in the previous symposia, is beyond question.

According to the early announcement of the organizers, the purpose of the Seventh Symposium was to increase our knowledge of the physics and chemistry of flames. This has been accomplished admirably. A large number of papers are included on each facet of the subject. Some idea of the extent of information recorded may be gained from the following list of the divisions of the symposium and from the number of papers presented in each division: (i) mechanism of combustion reactions (31 papers); (ii) spectroscopy of flames (5 papers); (iii) ionization in flames (6 papers); (iv) structure and propagation of flames (17 papers); (v) ignition and limits of inflammability (10 papers); (vi) interaction of flames and surfaces (9 papers); (vii) turbulence in flames (8 papers); (viii) combustion in practical flowing systems (11 papers); (ix) detonation and its initiation (9 papers); (x) special fuels (7 papers); (xi) instrumentation in combustion research (11 papers). It is, furthermore, clear from this list that in this volume there is plenty to interest the theoretical as well as the practical combustion scientist.

In a review of a book of this nature it is obviously impossible to single out any particular papers for discussion. Considerable progress has been made on all aspects, both experimentally and theoretically: new methods, new data, and important new concepts have been advanced.

The absence of general survey papers on the main topics of the symposium (which were a notable feature of the previous symposia) is regrettable. These will no doubt be missed by many readers with a general interest in combustion problems who would have found the background information on each aspect highly useful.

However, one particularly good feature of the Seventh Symposium is that for each division there is a well-edited collective discussion covering all the papers presented in that division. This greatly assists in knitting together the various papers in each division and also stimulates further thoughts on the subject as a whole.

This volume, which has been well produced, brings up to date the latest thinking on the various aspects of combustion. As such it is an authoritative reference book which anybody interested in the subject would wish to possess.

K. C. S.

Vistas in Free Radical Chemistry. Ed. W. A. Waters, F.R.S. London: Pergamon Press, 1959. Pp. ix + 251. 75*s*.

This book commemorates the work of the late Professor M. S. Kharasch, who died in 1957. Kharasch was one of the founders of free-radical chemistry, and he built up a large and successful research school at Chicago, which made many outstanding discoveries in organic chemistry. Kharasch was interested in demonstrating reaction mechanisms by classical organic chemical techniques, and his work made little use of involved mathematical analysis.

When one looks into Kharasch's publications, to find out what he has done, one is soon confronted by an almost intractable problem of deciding what he has not done, for the work is truly extensive. This book conveniently records and classifies some 234 published papers, and a sample of twelve are reprinted here. The reviewer rather regrets that few of these are post-war, for his later papers particularly were models of well-written, clear, and lucid chemical reports.

The book will be most appreciated for the review articles on the present state of free radical chemistry. K. O. Kutsche and E. W. R. Steacie have contributed an outstandingly valuable review of a much-reviewed subject, the kinetics of the simpler radicals in the gas phase. W. A. Waters, looking to the title of the book as his text, contributes a stimulating article on what is not yet known about the behaviour of radicals, with particular emphasis on the little explored oxidation and reduction reactions of radicals, and briefer mention of the response of radicals to inductive effects.

The importance of inductive effects on the point of attack of electrophilic or nucleophilic radicals on organic com-

pounds is taken up by the other contributors, who review more specialized parts of free radical chemistry. It is now clear that although their influence is greater in reactions with an ionic mechanism, inductive effects operate quite strongly in free radical reactions.

In a rather more anecdotal vein, F. R. Mayo describes his protracted struggles at Chicago to obtain repeatability in the addition of HBr to allyl bromide, which culminated after two years of effort in the discovery of the peroxide effect in additions to olefins. An account of Kharasch's part in the establishment of a synthetic rubber industry in the U.S.A. under the stress of war, and subsequently, is contributed by Cheves Walling.

To sum up, the book is a fitting memorial to Professor Kharasch in recording appreciations of his work, and it is of value in pointing out further developments of this work which may be made by industrial and academic research organizations. J. H. T. B.

Conference on Hyperconjugation. Conference co-chairmen: V. J. Shiner, Jr and E. Campaigne. London: Pergamon Press, 1959. Pp. viii + 168. 35*s*.

The expression hyperconjugation is generally employed by organic chemists to denote the conjugation of any alkyl group with an unsaturated linkage or, expressed in other terms, a delocalization of C–H electrons. The term was first used in 1941 in connexion with quantum theoretical considerations applied to ground states and spectroscopically excited states. The conception has since been applied to account for observed deviations from the normal, of heats of formation, of bond lengths, and in reaction kinetics. In a relatively new subject such as hyperconjugation, which has so many different lines of approach, it is proper that the various exponents should meet to discuss their several views. The University of Indiana and the members of its Chemistry Department are to be congratulated not only in having brought about such a meeting, but also of ensuring that the papers at the meeting should be authoritative and cover the topic in the widest possible way. The reviewer is credibly informed that the discussions at the symposium were sufficiently lively to ensure a balanced presentation of the various aspects of the subject when the account came to be prepared for publication.

The currently accepted experimental evidence for hyperconjugation falls into five main groups: (*a*) shortening of the C–C bond adjacent to a triple or double bond; (*b*) the heat of hydrogenation of the double bond of homologues of ethylene is less than the heat of hydrogenation of ethylene itself; (*c*) the light absorption of hyperconjugated molecules differs markedly from that of analogous unconjugated molecules; (*d*) hyperconjugation has an effect on the dipole moment; (*e*) hyperconjugated molecules differ in chemical reactivity from unconjugated analogues.

From a consideration of evidence of this nature, Professor Dewar expresses the opinion that experimental evidence for hyperconjugation in olefins and dienes is inconclusive and unsatisfactory. Dr L. E. Sutton expresses a somewhat similar opinion based on a consideration only of bond lengths.

But it is clear that these views on hyperconjugation are not unanimous. Professor R. B. Turner draws attention to the factors which determine the heat of hydrogenation of the double bond of an olefin. The progressive substitution by methyl groups of the hydrogen atoms of ethylene diminishes the heat of hydrogenation of the resulting compounds. The effect, as far as the observations go, is independent of the nature of the alkyl group and cannot be accounted for by steric effects. It is not possible to do more from such observations than to establish that there is such an effect; the interpretation of the results must depend on other lines of approach. A number of papers dealing with the theoretical treatment of hyperconjugation were included in the conference; of these the contributions by R. S. Mulliken and by Streitweiser are of special importance and provide a basis for accepting the idea of hyperconjugation.

An interesting paper by D. A. McCaulay and A. P. Lien of the Standard Oil Company of Indiana deals with the solubility of aromatic hydrocarbons in fluoboric acid; the basicity of the alkyl benzenes increases with the addition of each methyl group, so that the cation from mesitylene is more stable than that from toluene by a factor of 280,000. The formation of the aromatic cation is assumed to follow addition of the proton from fluoboric acid, and its stabilization is brought about by hyperconjugation from the alkyl group.

An important part in the development of the theory of hyperconjugation has been played by the Baker–Nathan effect. It had already been observed in 1935—some few years before the introduction of the expression hyperconjugation. Evidence for this effect is derived from reaction kinetics; established chemical theory postulated that the rates of reaction should be influenced in the order of methyl < ethyl < *isopropyl* < *ter*-butyl. There are, however, a number of established observations in which the influence of the alkyl group is in the reverse order. It would appear that a considerable body of opinion is now prepared —tentatively at least—to consider this effect as due not to hyperconjugation but to other causes.

In a review such as this it is only possible to select some of the papers for special mention and in this the writer has been guided to some extent by his own personal preferences rather than any conscious selection of important papers.

This is a book which can be confidently recommended to the attention of all who practise organic chemistry, either in its theoretical aspects or in its application to more practical problems. W. J. H.

Tiefbohrtechnik. Gottfried Prikel. Vienna: Springer-Verlag, London: I. R. Maxwell and Co. Ltd, 1959. Pp. xii + 414. 112*s*. 6*d*.

In this profusely illustrated volume every phase of rotary flush drilling technique is described with considerable skill and discernment. The contents are spread over 22 sections, each subdivided into appropriate major and secondary headings where subjects are treated theoretically, mathematically, and practically. The customary drilling methods in vogue with their associated variations and ancillary apparatus and tools devised to penetrate strata of many kinds receive critical analysis, with descriptions of all the popular bits, cutters, and devices designed to assure safety, speed, verticality, and economy. Graphs and tables are liberally introduced to illustrate matters under consideration.

40 pages are devoted in Section II to a detailed description of modern drilling practice and the large variety of drilling bits employed to attack the many types of strata encountered. All the factors that influence footage rates are critically examined, such as weight on bit, nozzle, velocity of jet, revolutions, etc.

Considerable space is given in Sections III–V to an examination of performances under the varied conditions of operating, and to an analysis of the complex stresses, deformations, distortions, and deflections to which drill pipe is subjected when penetrating strata of differing resistance or inclination. The nature and causes of drill pipe failures through fatigue, wear, bending, buckling, erosion, or ill-treatment are discussed in Sections VI–VIII, with advice on methods of prevention or amelioration. Advice on tool joints and their proper handling to reduce damage is

singularly apt. Section IX discusses fully mud-flush technique and the constitution of colloidal clay–mud mixtures designed to ensure the preservation of essential properties under the changing conditions to which they become exposed during drilling operations. The factors which cause deterioration of quality during circulation in wells are discussed, and the customary methods of measuring such properties are described. The importance of chemical additives to transmit or sustain desirable physical properties is stressed, and illustrated descriptions are given of the instruments used for testing the properties of mud mixtures. Problems that arise when drilling through soluble salts such as sodium chloride, gypsum, or anhydrite are debated, and the value of the oil emulsions and aerated fluids for special purposes is demonstrated.

Flow technology is featured in Section X, where fractional resistance in its various forms is theoretically analysed and graphically illustrated. The very important subject of slant drilling receives perspicacious handling with figures that illustrate cause and effect when involuntarily drift occurs. Ways and means of arresting or impeding the tendency of bits to depart from a vertical path are named. In Section XII are described all the usual methods of measuring deflection, with illustrations starting with the acid bottle and not omitting Alex Anderson's method, which first exposed the prevalence of deflected holes, thereby demonstrating the fallacy of conclusions previously reached regarding underground structure contours based on the assumption that the wells were vertical.

All aspects of directional drilling come under purview in Section XIII, with descriptions and figures of whipstocks and other devices and methods employed to deflect and orientate bits to reach a predestined position at a prescribed depth. In this connexion attention is appropriately called to the value of the flexible drill stem originally invented by J. Zublin for rotary slush drilling at any desired angle up to the horizontal. This ingenious apparatus, adaptable to any string of drill pipes, is finding increased use for inclined or horizontal side hole drilling into tight consolidated oil sands, thereby increasing the infiltration area for oil drainage from sluggish beds when gravitation largely supplants gas as an expulsion agent.

Section XIV deals with oilwell casing types and problems arising from its manipulation and usage in oil wells. Particulars of the various classes of standard joints, collars, or sockets used are described and illustrated. This is followed by an analysis of the stresses to which tubing is subjected by such factors as weight of columns, external and internal pressure, bending, and the like, with notes on corrosion and erosion and their prevention. Such questions as strength, elongation due to weight under suspension, temperature, and acceptable relationship between diameter of casing and drill pipe are critically examined. Useful tables are interposed to illustrate examples of casing programmes used in the U.S.A., Germany, and Austria. Such matters as safety factors, casing heads, shoes, flanges, and Xmas trees are discussed with illustrations.

Blow-out preventers, almost exclusively of standard American manufacture, are described and figured in Section XV. The function of cementation (grouting) projects and the methods employed to ensure their effective completion are treated at length in Sections XVI–XIX. The varying properties that must characterize cement mixtures for use in deep wells are enumerated, and the value of accelerators or retarders in adjusting setting time, and the rate of introduction, are discussed. Descriptions of special cement to combat particular conditions are given, also advice is tendered on the estimation of cement volumes to ensure a satisfactory distribution and binding of cement in the annulus between the borehole walls and the casings. Squeezing operations are described, and the needful equipment is illustrated.

Fishing operations are explained in Section XX, and the usual tools and appliances employed for retrieving, sidetracking, or crushing lost or damaged objects are reviewed and illustrated. These include the many forms of taps, dies, overshots, internal and external cutters, packers, and other devices designed to take a firm grip of damaged, broken, or disconnected drill pipes or bits when cleared of any encircling or overlying debris by washing. The utility of magnetic apparatus for the recovery of lost small steel objects is stressed.

Formation testers and pressure recorders are figured in Section XXI, and a lucid description is given of the popular Johnston equipment. The final Sections XXII and XXIII deal with perforating and coring programmes and describe the appliances in general use, of which the gun perforator is given priority. Attention is called to its growing importance by using high-velocity shaped slugs which penetrate not only the casing but enter and fracture the oil-bearing formation, thereby encouraging freer oil admission. Many of the most generally-used coring apparatuses are described, as also is that used for obtaining side wall samples.

Three useful indexes are included, and one lists articles to which reference has been made in the text. Another gives the names of firms manufacturing the apparatus described, and a third is a general index of the contents.

This well documented book can be recommended to all with a knowledge of German desirous of acquainting themselves with present day methods of drilling deep wells and preparing them for a useful productive life. A. B-T.

Methods for the Analysis of " Octel " Anti-Knock Compound. London: The Associated Ethyl Co. Ltd., 1959.

Methods recommended by the Company's Analytical Methods Committee are detailed and are preceded by notes on the general precautions which must be taken when handling " Octel " samples. The methods include specific gravity, total lead, ammonia-soluble lead, combined halogens, and acidity or alkalinity.

Gas–Liquid Chromatography. Detectors for Use with High-Efficiency Columns. R. P. W. Scott. Benzole Producers Research Paper 2–1959. London: Benzole Producers Ltd, 1959. Pp. 44.

An investigation into the possible application to high-efficiency chromatographic columns of (*a*) the argon detector and (*b*) the flame-ionization detector. In each case details of construction of the detector are given and results of the work are fully reported.

The general conclusion is that the sensitivity of both detectors is more than adequate for high-efficiency columns, slight preference being given to the argon type.

ERRATUM

Abstract **745**, 1959: In this abstract the word " hydrogenation " should be replaced by " hydration " wherever it occurs.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1486. General observations on petroleum origin. (In German.) G. Stadnikoff. *Erdöl u. Kohle*, 1958, **11**, 293–6.—Two different theories of petroleum origin are discussed. Adherents to the first theory maintain that petroleum did, and can still, originate from mineral materials. This theory was unrecognized until it was observed that petroleums are optically active and contain porphyrin derivatives of chlorophyll. Adherents to the second theory assume org—chiefly vegetable material—as original substance. This—regarded by chemists and geologists as the sole scientifically based theory—controlled science until the 30th year end. The discovery by geologists that large amounts of petroleum existed in sec deposits revived the primary deposit question. Since the primary deposit is unknown, geologists were forced

T

to assume that rocks exist as petroleum-containing reservoirs and mother rocks. Confusion over the nature of mother rocks caused Russian geologists to revert to the mineral theory. Deposits of petroleum, pronounced as a product of intensive bacterial reduction of org material by anaerobic bacteria, are formed under water, *i.e.* in complete absence of atm O_2. This is guaranteed only when the base of the geosyncline is shielded by a thick H_2S layer. Ideal conditions are produced for petroleum formation. Reduction of org substances with simultaneous cracking of high-mol natural cpds under the sea surface is confirmed by investigations of the bitumens in the mud of the Gulf of Mexico. The bitumens are shown to be more paraffinic–naphthenic, the deeper the mud lies in the deposit. Arising from the conceptions of primary and sec petroleum deposit formations, the top and bottom clay rocks of the petroleum horizon of Uchta, European U.S.S.R., were investigated at different levels. Results and conclusions are discussed and tabulated. R. T.

1487. Chemical investigations of a sapropel from the middle Adria. (In German.) E. Seibold. G. Müller, and H. Fesser. *Erdol u. Kohle*, 1958, **11**, 296–300.—The sapropelitic sediment of the middle Adria shows characteristic fine stratification of annual layers with a high org cont. Trace element cont estimated by a quant-spectrochem process is discussed. Val for V/Mo and Corg/N quotients confirm those given in the literature, so that this sediment presents a recent model for many dark shales. Bitumens are extracted from the org substance by a simple chromatographic process with selective solvents and resolved into three groups. The results are discussed and compared—with a supporting diagram—with other recent sediments from the Lias E of NW Germany and crude oils. 15 refs. R. T.

1488. Palynology added to oil finder's tool chest. F. J. Gardner. *Oil Gas J.*, 6.7.59, **57** (28), 165.—Since world war II the study of fossil spores and pollen has proved a valuable means of identifying formations for correlation and for providing data about past environments. They are more abundant than foraminifera and macro-fossils, are generally well preserved, and are found in almost all sediments, including salt. Palynological studies are now being carried out by all major companies. C. A. F.

1489. Clear away range-township fog. C. C. Mathey. *Oil Gas J.*, 6.7.59, **57** (28), 167.—The rectangular grid system of land survey as used in the U.S.A. and Canada is described, the difference between the U.S.A. and Canadian systems being noted. In the states of the U.S.A. where the system operates, measurements are based on a chosen meridian and latitude intersection. Quadrangles known as townships are then laid off essentially 6 miles square, and each township is designated N or S by township numbers and E to W by range numbers. In Canada townships are not designated N to S, and instead are numbered northwards from the 49th parallel. Ranges are usually denoted as W ranges as all meridians in Canada are W of the principal meridian. In both countries the townships are divided into 36 sections. Diagrams illustrate the methods. C. A. F.

1490. Double calcimetry and the calcilog. C. Berger. *Rev. Inst. franç. Pétrole*, 1959, **14**, 55–71.—In double calcimetry the carbonate content is determined on the crude cuttings and on the washed cuttings, and the results are plotted against well depth, each curve being a calcilog. The difference between the two curves may be informative, and characteristic for certain rock types. In some cases the difference and one of the curves are plotted.

These curves, and especially the pairs of curves, can be of value for purposes of correlation, not only for wells on a single structure but also between separate structures.

The data can be plotted as drilling continues. On some occasions double calcimetry may indicate that a new formation has been met, as a consequence of the finer particles reaching the surface along with coarser material which had been drilled at a shallower point. Evidence of caving may also be obtained.

Examples are given and discussed. G. D. H.

1491. Insoluble residues provide good regional correlations. E. McCracken. *World Oil*, 1.8.59, **149** (2), 79.—Detailed study over many years of the uplifted Palæozoic rocks of Missouri has shown that insoluble residues, particularly cherts and silicified fossils, are highly successful in providing regional correlations which can be carried S to Mississippi, N to Minnesota, and SW to Kansas, Oklahoma, and Texas. Marker beds established from residues can be carried from outcrop to the subsurface, and it is possible to locate the stratigraphic position of sand lenses and correlate them across barren areas. The technique of insoluble residue studies is outlined and details of the correlation are given. The method is obviously limited to carbonates, and it cannot be applied to formations where correlations are based on studies of calcareous microfossils. It is particularly useful in the zoning of long calcareous or dolomitic sections such as the Canadian of Missouri and the Arbuckle in Oklahoma. C. A. F.

1492. How to use aerial photos in pipelining. J. D. Mollard. *Pipe Line Ind.*, Aug 1959, **11** (2), 31–4.—The value and limitations of aerial photography in identifying topographic features are discussed. Information about the soil composition and condition can be obtained and areas of instability detected. Much of the location study can be completed before the field survey. G. B.

1493. Pauley says strike off Mexico is major find. Anon. *Oil Gas J.*, 1.6.59, **57** (23), 113.—Wildcat 239 Santa Anna, located 1 mile offshore from State of Tabasco in Bay of Campeche, Mexico, tested 1680 bd of 38° API crude from one upper zone in the Lower Miocene Encanto formation between 7000 and 10,000 ft. The well was drilled from a floating barge in 43 ft of water. Nine holes had previously been drilled in the Bay of Campeche, five of them producers rated at 500 bd each. J. C. M. T.

1494. Iran opens new areas for operating agreements. G. E. Crays, G. W. Underwood, and T. B. Young. *Oil Gas J.*, 22.6.59, **57** (26), 90–6.—The known geology and petroleum prospects of the three areas in Iran known as Districts 8, 14, and 18, recently made available to foreign operators, are discussed. So far as is known, the stratigraphy of the three areas is similar. Almost a complete geological column from Pre-Cambrian to Recent is present. The best prospects are in the Oligo-Miocene, which has up to 9000 ft of limestone, reef limestone, marly thin bituminous shales, salt, anhydrite, rare sandstone and conglomerate, gypsum, and local lava flows, and in the Cretaceous, which has up to 12,000 ft of dark shale, limestone, reef limestone, marl, dolomite, chert, flysch, and breccia. The Oligo-Miocene of Central and N Iran includes the equivalent of the Asmari limestone. In District 18 this zone is *ca* 2400 ft thick and in the Zagros Mountain front W of Districts 8 and 14 more than 3600 ft. The flat desert of District 18 is one of strong tectonics with many surface structures and some faulting, all readily discernible on air photos. The mountains on the N, E, and S boundaries are complexly deformed and the W part includes a number of salt peaks and domes associated with the folded Semnan area. Districts 8 and 14 are similar except that basins are more elongated, surface structures in the valleys are less common owing to masking by young deposits; some folding has occurred up to recent times. Productive capacity or potential of Iran's known oilfields are presented. J. C. M. T.

1495. Kuwait, Libya, yield important strikes. Anon. *Oil Gas J.*, 1.6.59, **57** (23), 114.—Mina Gish exploration well, 21 miles W of Burgan field, Kuwait, tested 1660 bd of 34·5° API crude through a ¾-inch choke from the Ratawi limestone at 10,000 ft. 1-Emgayet, 200 miles S of Tripoli, Libya, tested 750 bd of 35° API clean oil from *ca* 4100 ft. J. C. M. T.

1496. Ostracods of the Aptian-Albian of Apt. H. J. Oertli. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1499–537.—Samples from the Gargasian and Albian at Gargas hill near Apt (Vaucluse Department) have yielded 20 ostracod species. Most of the species are new. There is no evidence that there was direct connexion between Provence and the Paris Basin: some species are common to the Aquitaine Basin. The forms belong to the Cytherellidae, Bairdiidae, Cyprididae, Macrocypridae Cytheridae, and Trachyleberididae. They are described and illustrated. G. D. H.

1497. Petroleum reconnaissance in the Majunga Basin (Madagascar). R. Brasseur. *Rev. Inst. franç. Pétrole*, 1959, **14**, 3–16.—The Majunga Basin has alternations of marine and continental rocks ranging Permo-Trias to Quaternary in age, with basaltic flows of Cretaceous age. In the S Bajocian bituminous shales outcrop, and the Ankaramy well in the N found bituminous sands at shallow depth near the top of the Isalo formation (Lower Mesozoic). Several horizons below the basalts show source rock features. A number of horizons have possible reservoir rocks, and include sands and carbonate rocks. SSW–NNE longitudinal faults are seen at the surface in pre-Cretaceous rocks. There are also transverse faults. Some signs of folds are known. In the littoral zone the basement may be 5000–6000 m deep.

The evident structural traps are associated with faults. Lenticularity could be important. The limited use of geophysics has left the structure at depth over much of the basin still obscure.

A provisional geological map, sections, and facies diagrams are given. G. D. H.

DRILLING

1498. Drilling engineering: key to continued progress. M. M. Brantly. *Drilling*, July 1959, **20** (9), 64.—It is becoming economically impossible to practise drilling without the application of sound engineering principles. Particularly, a proper balance must be struck between capacity of drawworks, power of prime movers and pumps, and sizes of drill pipe. Economies due to the increased rate of penetration secured by use of jet bits, turbo-drills, or heavier drill collars must be carefully balanced against the increased cost of equipment or greater wear and tear involved. Well-trained specialists are needed to assess all relevant factors. J. C. M. T.

1499. The possibilities of extending turbo-drilling to drilling for water. R. Rouviere and W. Tiraspolsky. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1547–52.—Turbo-drills now range from 10 to 5 inches dia, and smaller ones are in the prototype stage. Adequate pump power is essential, and large drill-pipe makes the transmission losses small. For deep water wells conventional rotary might involve 5–6 times the effective drilling time for a turbo-drill, thereby offsetting the increased cost and pump requirements for the latter. A mobile unit might make it practicable to use turbo-drilling for shallow holes.

Bits must be suitable for the turbo-drill for efficiency. Application to slim-hole drilling in exploration seems feasible. For small dia the turbines may have as many as 400 stages. The Russian T S 4–5-inch turbine has 240 stages, is 13·43 m long, 12·7 cm dia, and weighs *ca* 1000 kg. A 1·2 density mud flowing at 12 l/sec gives power of *ca* 69 hp and a speed of 880 rev/min.

Turbo-drills could be applied in mining and civil engineering projects. 17½-inch bits have already been used at Lacq. Horizontal boring ahead of galleries should also be possible by turbo-drill. G. D. H.

1500. A year of turbo-drilling (1957–1958). J. Reynal. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1553–62.—In turbo-drilling the drill-stem does not rotate. This reduces war and breakage. Equipment to fix deviation could be placed above the turbine. Measuring devices also could be placed in this position. The specific power applied to the bit is more than twice that for conventional rotary, giving more rapid advance.

Comparisons between the turbo-drill and rotary at Lacq showed advances 24·5 m/d for the former and 15 m/d for the latter in the SW sector, and 29 m/d and 22 m/d, respectively, in the E sector, for the 10-inch turbine and 12¼-inch bit. With 8½-inch holes the drilling rate was 4·7 m/hr (4·7 times faster than rotary); each tricone bit did 23 m (81% of rotary). In compact marly-limestones diamond bits gave 452 m with the turbo-drill, and 140 m with rotary, but the advance rate was less than for tricones. Some turbines operated for 220 hr.

For good operating conditions two-thirds of the pressure drop should be in the turbine. The rotary requires 200–600 hp by pumps; turbo-drills need 700–800 hp. Tripping involves a far greater proportion of the time for the turbo-drill than for rotary. G. D. H.

1501. Construction problems for turbo-drills. R. A. Ioanessian. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1615–21.—Relationships are known between the hydraulic power of a turbine, the mud flow and density, the number of stages and characteristics of the turbine, and various other factors. Among other things it can be concluded that for max power at the bottom the number of stages must increase with depth, and also that two-thirds of the total pressure drop should occur in the turbine. Drill-pipe size is important in achieving efficiency. Some advantages can be obtained by modification of the design of the turbine, and costs may be reduced by using plastics for the construction.

The speed of rotation is an important factor in determining the rate of advance. Diamond bits turning at 2000–3000 rev/min might be driven by turbines with less than 30–35 stages. In Russia experiments have been made on measuring the rate of rotation, with a view ultimately to control at optimum rates. G. D. H.

1502. Scientific study perfects perforating tools, methods. W. T. Bell, M. P. Lebourg, and J. Bricaud. *Drilling*, July 1959, **20** (9), 62–3.—A flash X-ray photographic apparatus has been used to record the stages of collapse of shaped charge liners. It has been confirmed that velocity of jet stream approaches 30,000 ft/sec at forward tip, while rear portion travels at only 15,000 ft/sec. It is this difference which causes the metallic jet to lengthen, extending penetration. Improper design or manufacture of shaped charge may lead to one portion of jet overtaking another, resulting in reduced penetration. Effect of liner geometry on jet performance studied by same technique led to elimination of slug from perforated hole and design of improved charge producing larger holes at higher clearances without loss of penetration. Penetration of bullet-type guns has been tripled by use of powders which impart a higher proportion of the released explosive energy to the bullet, after investigation of bullet acceleration using a continuous-reading strain gauge technique. Powders have been developed to suit high temp in recent deep wells. J. C. M. T.

1503. New tool pinpoints perforating depths—saves rig time. Anon. *Oil Gas J.*, 29.6.59, **57** (22), 79.—A new combination tool combines a γ-ray logging device, casing collar locator, and

a perforating gun in a single down-hole unit. It can be used with either bullet or jet guns. The tool eliminates shooting-depth errors due to failure to identify the proper collar when perforator and collar locator are run separately, saves rig time, and in most cases gives positive evidence after firing that shots are properly spaced. J. C. M. T.

1504. Calculation and design of modern deep well drilling tools. (In German.) Anon. *Erdöl u. Kohle*, 1958, **11**, 330–3.—In rotary deep drilling installations—especially in German construction—a series of new constructions has been developed with the object of increasing performance with simultaneous automatization, wt reduction, and shortening erection and dismantling times. Development progress and operational performance *in situ* are awaited. For permanent results it is assumed that, by applying knowledge of the higher strength of materials and the new research results on static and dynamic forces up to oscillation and damping problems, the installations are calc and dimensioned to conform to all requirements of deep drilling practice. R. T.

1505. Unusual techniques solve Wilmington subsidence problems. D. Allen. *World Oil*, 1.8.59, **149** (2), 86.—Operations in the Wilmington area, Los Angeles, California, have been hampered since 1947 by casing deformation and failure due to earth subsidence and slipping, and heavy expenditure has been incurred in repairs and preventive measures. Of the 3000 wells in the area 25–30% are in the max danger area. The movements have occurred at *ca* 1550 ft and 1700 ft within incompetent shales along horizontal shear planes close to an angular unconformity which separates flat-lying Upper Pliocene beds from an underlying strongly faulted anticline. Methods used to combat the problem include: (1) the scraping of large dia pockets in the zone of movement so that casing would bend rather than shear under stress; (2) the use of long bell holes and high strength gel packs; and (3) expansion-compression joints. C. A. F.

1506. Hard surfacing can increase life of tool joints and drill collars. R. R. Fayer. *World Oil*, 1.8.59, **149** (2), 68.—Hard surfacing on tool joints and drill collars is becoming standard field practice, resulting in increased life of parts and lowering of replacement costs. Application is by submerged arc and there are various techniques in use. Preheat is necessary, most operators using *ca* 600° F on higher alloy pipe and *ca* 300° F on lower alloys. Tool joints are usually given a hard surfacing band *ca* 2–4 inches wide, 12 inches back from the box end of the pipe. Two layers are used on badly worn joints. On drill collars the bands are *ca* 12–18 inches wide, *ca* 3 ft in from each end. Worn collars are also repeatedly rebuilt on both ends, using a medium carbon, low alloy deposit, as these are not replaceable. The equipment is usually portable and includes the submerged arc head and a 600-amp power source. Application procedures are outlined. C. A. F.

1507. Dual elevator systems. R. O. Frederick. *Drilling*, Aug 1959, **20** (10), 66.—The cable-tool method of running casing, in which dual elevators are used, was applied to handling drill pipe in rotary drilling *ca* 40 years ago, but was displaced by the use of slips. Failure of H.T. drill pipe due to wear and tear caused by slips has brought a revival of the dual elevator system. The deep wells drilled by Phillips in Texas recently employed dual elevators plus a hydraulic cushion on the drilling table, and trips took only 6–12 sec longer per stand than when using slips. A newer system, known as the DuoMatic, involving a special platform secured to the rotary table, two side door elevators, and equipment to move the elevators laterally and transfer links from one set of elevators to another, is said to equal trip time using slips, and promises to be faster as crew experience grows. J. C. M. T.

1508. Problem drilling area tamed by water base EP lubricant. W. C. Browning. *Drilling*, Aug 1959, **20** (10), 71.—Two Louisiana offshore holes drilled with lime base mud were abandoned after much trouble in region of 13,000 ft, due mainly to pipe sticking. A third well drilled with a low water loss calcium mud had ¾ gal water base EP lubricant/brl mud added at 11,600 ft, whereupon drilling torque dropped, bit life was extended 30–35%, and the hole was completed to target at 16,100 ft without difficulty. The first abandoned hole was then deepened using ¼ gal EP lubricant/gal. This concn was increased to 1 gal/brl when some tight spots developed at 13,200 ft. After this increase all tight spots disappeared and hole was completed to 16,100 ft without further trouble. The beneficial effects of the additive were long-lasting, and it was later found that ¾–1 gal of water base EP lubricant/brl mud will last 4–6 weeks drilling without maintenance of any kind. J. C. M. T.

1509. How to plan a directional well. J. B. Buchanan. *World Oil*, July 1959, **149** (1), 107.—The basic terminology of the geometry of a deviated well is briefly described with an example of a drilling plan. Plotted results are shown and tables are included which can be used to determine the max build-up throw of a well in any direction when the drift angle is built up at rates of 2°/100 ft, 2½°/100 ft, and 3°/100 ft. C. A. F.

1510. Calco appraisal form helps fit the rig to the job. J. Pedersen. *Drilling*, Aug 1959, **20** (10), 69.—As an aid to selecting the best quotation for drilling contracts, an operating company keeps a record of the performance of every rig which has been employed. Appraisal is made by at least two company engineers or drilling supervisors. Results are then employed to calculate which contractor's quotation will give the lowest total drilling cost for a given well, taking into account the probable drilling rate. Drilling cost reductions are claimed. J. C. M. T.

1511. Gas drilling techniques aid well completion, workovers. V. Smith, L. G. Kelly, and E. H. Mayer. *Drilling*, Aug 1959, **20** (10), 73.—13 workover jobs (cleanouts and washes) in California have been performed using gas, air, or aerated or gaseated fluids. 12 of these appear to have been successful. Fracturing of low perm formations with air or gas appears to offer advantages. J. C. M. T.

1512. DST—success or failure? J. Grynberg. *Oil Gas J.*, 22.6.59, **57** (26), 106–13.—As oil exploration becomes concerned with thinner and dirtier sands, the ratio of inconclusive DST increases. One reason for an inconclusive test is that clear water due to returned mud filtrate may be misinterpreted as formation water. Graphs and tables are presented for determining probable bulk of filtrate which will be returned before formation fluids can appear per ft thickness of reservoir for various hole dia, porosities, and invasion dia. An alternative approach is to measure resistivity of produced fluid and compare it with resistivity of filtrate of drilling mud used. A continuously recording resistivity instrument incorporated in a DST system would be a valuable tool. J. C. M. T.

1513. Recent results obtained in rotary drilling at Lacq: Lacq 123. C. Menetrier. *Bull. Ass. franç. Tech. Pétrole*, March 1959, (134), 345–53.—Lacq 123 on the SW flank of the structure was drilled to 12,800 ft in 113 days using an Ideco Super 7 × 11 rig. 57 m of 17½-inch hole were drilled in 5½ days. Setting 13⅜-inch casing took three days. From 585 to 3320 m drilling 12¼-inch hole occupied 65 days. Running 3320 m of 9⅝-inch casing took 16½ hr, and nearly six days elapsed before drilling 8½-inch hole could be undertaken. 582 m of 8½-inch hole were drilled in 27 days. 7-inch casing was run to 3902 m in 17 hr.

In 1952 366 days were spent in drilling Lacq 102 to 12,050 ft

by rotary, and in 1958 it took 129 days to drill Lacq 125 to 13,350 ft.

Improved rates without risk of excessive deviation have been obtained by using stabilizers and oversize drill-collars, allowing more weight on the bits. Large dia pipe enabled the rate of circulation almost to be doubled. Better knowledge of the rocks to be drilled allowed better choice of bits.

G. D. H.

1514. Fluid loss controlled by acrylic polymers as drilling mud additives. C. S. Scanley. *World Oil*, July 1959, **149** (1), 122. —The composition, properties, and uses of acrylic polymers in drilling muds are discussed; these have been used as additives in muds to control fluid loss. They are prepared mainly from acrylonitrile, acrylamide, and acrylic acid, and in muds they form attachments to the clay platelets, reducing water loss by a physical blocking action. The visc of the fluid phase is also increased, so reducing filtration rate. The effect of polymer variables on mud systems is also discussed. Five refs.

C. A. F.

1515. How to get the most from your attapulgite clay muds. A. I. Coyle and E. W. Sawyer. *Drilling*, July 1959, **20** (9), 68–9.—Processed attapulgite is increasingly used in muds where salt water, gypsum, or high temp are involved. For fresh water, one-third less attapulgite is needed than bentonite to obtain the same visc; moreover, it is insensitive to contaminants and abnormal pH. Gels of attapulgite mud may be adjusted with any dispersing agent effective with bentonite, but less are required. For attaining low water loss either CMC or starch may be used. In salt water attapulgite gives four times the yield of bentonite. In concentrated gypsum muds attapulgite gives twice the yield of bentonite. Attapulgite is not affected by oil or the emulsifiers used for making oil-in-water suspensions; when used in oil emulsion muds attapulgite retains its resistance to contaminants. In a neutral gypsum mud it is not affected by temp of up to 370° F. These advantages outweigh the cost, which is $10–$15/ton higher than bentonite at the well site. J. C. M. T.

1516. Slash pH in weighted muds. L. D. Wiener. *Oil Gas J.*, 29.6.59, **57** (27), 89–96.—A weighted high pH calcium mud can be converted cheaply to a neutral mud suited to high temp without severely disrupting its stability. This is done by removing lime by reaction with mixed sodium bicarbonate and calcium sulphate. A deflocculant and a drilling mud surfactant must also be present to avoid abnormal visc and gel strength in the process. If starch has been used for filter loss control it should be replaced by carboxymethyl cellulose some time before conversion. It is feasible to convert the system while drilling ahead. Field trial data are presented.

J. C. M. T.

1517. Exploratory drilling in 1958. B. W. Blanpied. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1117–38.—This 14th annual report, based on data gathered by the Cttee on Statistics of Exploratory Drilling, is the 23rd article of its kind published in the *Bulletin*.

During 1958, 13,199 exploratory holes were drilled in the U.S.A. and Alaska. Of these, 6950 were new-field wildcats, 3191 were new-pool tests, and 3058 were outposts. Among the new-field wildcats, 786 were successful; among the new-pool tests, 809 were successful; and among the outposts, 972 were successful.

The total exploratory footage drilled in the U.S.A. and Alaska in 1958 was 61,483,911 ft in the 13,199 holes, or 4661 ft/hole. These figures are comparable with 69,136,266 ft drilled in 14,707 exploratory holes, with average depth of 4701 ft, in 1957.

Other papers in this issue outline in detail developments in the various states during 1958. E. N. T.

PRODUCTION

1518. Viscosity correlation for gas saturated crude oils. J. N. Chew and C. A. Connolly. *J. Petrol. Tech.*, Feb 1959, **11** (2), AIMME Tech. Paper No. 8050, 23–5.—Visc data for 457 crude oil samples were used. These were obtained in a rolling ball viscometer. Solution GOR was 51–3544, bubble-point pressure 132–5645 psia, reservoir temp 72°–292° F. At a fixed soln GOR gas-saturated oil visc are linearly related on logarithmic co-ordinates to the dead oil visc. Differential liberation data were used.

By means of the correlation visc of gas-saturated crudes can be estimated with a reliability approaching that of routine lab measurements. G. D. H.

1519. New experimental model for studying transient phenomena. B. L. Landrum *et al. J. Petrol. Tech.*, Feb 1959. **11** (2), AIMME Tech. Paper No. 8052, 22A.—The model consists of ¼-inch brass plate as the reservoir, with ¾-inch copper pipe soldered through to represent a well. A 2-inch layer of Pyrex wool reduces convection and radiation losses. Hot water is passed through the pipe and the temp of the plate is measured by copper–constantan thermocouples at 32 points. For unsteady-state conditions the shape of the isopotentials changed with time; early in the depletion flow was radial, but later most flow was from the side where most reservoir occurred. G. D. H.

1520. Measurement of the formation factor of rocks. F. Lebreton. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1538–46.—The ratio of the resistivity of a rock saturated with water to the resistivity of the saturating water is the formation factor. However, rocks of the same porosity can have different formation factors. For the formation factor to be related to rock morphology the rock must not react with the electrolyte; the rock must be non-conducting; the rock must not contain non-conducting fluid. Studies of formation factors have led to a relationship of the form $F = a/P^m$, a being approx unity, m *ca* 2, and P being the porosity. Lab measurements should be made on cyl samples from cores taken at 30-cm intervals, one specimen being parallel and the other perpendicular to the bedding. These must be cleaned and properly saturated with the electrolyte, which may be made up to represent the formation water. Bipole methods are simpler than quadripole methods for measuring the resistance of the saturated sample, but care must be taken to minimize end effects.

The technique for coating the cyl with a plastic is described, and for depositing metal on the end faces to ensure good electrical connexions. G. D. H.

1521. Field test confirms accuracy of new bottom-hole pressure gauge. G. Lozano and W. A. Harthorn. *J. Petrol. Tech.*, Feb 1959, **11** (2), 26–9.—The Maihak gauge consists of a permanently installed bottom-hole transmitter connected by a single conductor cable strapped to the production tubing to a portable surface receiver. The transmitter is a sealed steel cyl closed by a steel diaphragm which is deformed by the pressure to be measured. This changes the tension in a steel wire attached to the diaphragm, altering its vibration frequency. The wire is vibrated by a dc pulse from the surface; a magnet involved in this also serves as a pick-up to transmit the vibration frequency to the surface. This is matched by adjusting the tension in a wire in the receiver. Ranges from 0 to 5900 psi are available. The surface receiver costs $1350, motor-generator $250, bottom-hole transmitters $150 each, and wire and clamps 7–15 c/ft.

Tests were made in three San Joaquin Valley wells, 1000–7000 ft deep: one installation was 13 months old. Measurements of build-up agreed closely with those for Amerada bombs. The Maihak bomb can be read to one division (6·5 psi for the case considered).

Lack of automatic recording is a disadvantage. Installation cost is high, and not justified for infrequent readings.
G. D. H.

1522. Thermal well treatment in petroleum deposits. (In German.) H. Bernhard, N. Lindermann, and H. Meder. *Erdöl. u. Kohle*, 1958, **11**, 231–4.—Darcy's law for variable visc is extended and the heat distribution around the well is investigated with the aid of an electrical analogy. A theoretical example shows that heating of the carrier near the well lowers the very high flow resistance and thereby results in considerable extra production. It is not necessary to heat the whole carrier. It appears from Darcy's law that extra production is a function of the distance of the well from the energy storer (edge water, gas cap, etc.). Field investigations confirm the calc result, but show that other factors influence the magnitude and duration of this extra production, which, however, cannot be measured. R. T.

1523. "Soda pop" flood scores high. W. B. Bleakley. *Oil Gas J.*, 29.6.59, **57** (27), 80–1.—Data from a 240-acre water-plus-CO_2 flood in Washington County, Oklahoma, suggests that the addition of CO_2 really assists secondary recovery. The water injection rate has been roughly doubled when CO_2 is also present. The CO_2 is produced at cost of ¼ cent/brl by combustion of natural gas, and mixed with injection water (costing 1½ cents/brl) at the foot of each injection well. Some reaction between CO_2 and hydrocarbons is suggested as CO, not present in the original reservoir gas, has been detected in the gas now produced. The reaction is thought to take place in the presence of magnesium carbonate, and to produce an organic salt with surfactant properties and CO.
J. C. M. T.

1524. 30 years of sand-control experience. P. E. Desjardins. *Oil Gas J.*, 1.6.59, **57** (23), 162–70.—Experience of 118 sand control jobs over 30 years at Black Bayou field, Louisiana, is analysed. The field produces from 55 zones of Miocene and Oligocene age by active water drive. It is concluded that for lasting success sand control measures should be installed before there is any movement of formation sand; no popular technique has been satisfactory after sand movement has occurred. Wire-wrapped screens have proved the most successful in open-hole completions and in perforated 7-inch casing; sand-consolidation plastic has shown greater success than screens in 5½-inch or smaller casing, but experience is limited. Sand can be controlled more effectively in open-hole completions than in perforated casing. Screen sizes that will retain 10% of the formation have been most successful. Screens as small as 0·008 gauge can be used successfully in open hole. Shaliness of sand and length of producing interval have no significant effect on sand-control success.
J. C. M. T.

1525. Theory and application of imbibition phenomena in recovery of oil. J. W. Graham and J. G. Richardson. *J. Petrol. Tech.*, Feb 1959, **11** (2), 65–9.—Theoretical studies of water imbibition into oil-saturated rock for fractured matrix formations showed the rate of water intake to depend on rock permeability, interfacial tension, contact angles, fluid visc, and saturations. Free gas saturation reduced the rate of water imbibition. Oil production from a lab model of an element of a fractured-matrix reservoir was rate sensitive; at a given fracture width the lower the injection rate the greater the oil recovery at a given vol of injected water. Increased fracture-to-matrix permeability did not necessarily give a proportional increase in the amount of water needed to recover the oil.

For the low rates of water advance existing over much of the reservoir five-spot area water imbibition is the main oil producing mechanism. In an ideal uniformly fractured system consisting of blocks comparable with those studied, no water will be produced until much of the recoverable oil has been obtained. At water break-through the oil recovery is smaller for high injection rates. G. D. H.

1526. Acid stimulation of a fractured shale zone. R. M. Dewar. *J. Petrol. Tech.*, Feb 1959, **11** (2), 19–23.—The fractured shale zone averages 1000 ft in thickness, and the fracturing seems to have no particular uniformity. Acid treatment, generally 5000 gal of 15% inhibited hydrochloric acid, has been used to remove carbonate scale from production equipment and for well stimulation by pumping into the formation, followed by zonal water in amount equal to the annular vol.

35 wells have been treated, generally with success. The increased output obtained is estimated at 1390 bd with no radical change in G.O.R. In some cases there was evidence of interference between wells. Decline rates after treatment were usually the same as before.

Cores averaged 5% carbonate, but there were highly soluble spots. G. D. H.

1527. Application of laboratory data in calculating the primary production history of the Cisco K-1 reservoir. W. C. Hardy and B. W. McArthur. *J. Petrol. Tech.*, Feb 1959, **11** (2), 61–4.—The Cisco K-1 reservoir is a lens, 6300 ft deep, in Scurry County. The original pressure was 2450 psig, the bubble point 1715 psig, the temp 121° F, and the initial oil in place *ca* $1{\cdot}44 \times 10^6$ brl of stock-tank oil. From 1952 to 1957 material balance showed no water advance.

Tracy's simplified form for the material balance relationship plots as a straight line when there is no water advance and no gas cap. This can be coupled with the instantaneous G.O.R. equation, linking the six variables common to all solution-gas-drive mechanisms. Assuming one of the variables at a particular pressure, it becomes possible to calculate the likely production performance. There are for typical plots of Tracy's functions four unique pressure values at which material balance alone gives the cumulative gas produced, and this allows the checking of the compatibility of PVT data with the production history.

A method is outlined for averaging relative permeability data obtained by the external gas-drive technique, and a ratio indicative of producing efficiency is defined. Using these methods, the actual and calculated production history for the Cisco K-1 reservoir is obtained and compared. G. D. H.

1528. How external casing corrosion is being controlled in East Texas. M. J. Olive. *World Oil*, July 1959, **149** (1), 101.—External casing corrosion is a serious problem in the E Texas field, and it has cost over $3 million in remedial work, in spite of shallow leaks below 500 ft. Average cost of repair is $2500. The most practical and economic method of overcoming corrosion in the area is by cathodic protection, a minimum 2-amp current being applied to each well through rectifiers. Over 450 wells have been treated. There are four main causes of corrosion in E Texas: (1) acidic water attack; (2) dissimilar resistivity cell attack; (3) bacteria attack; and (4) stray-current effect. Average cost of rectifier and ground-bed installation is $460, and the average cost per well is $300. Operating and maintenance costs are $12/well pa.
C. A. F.

1529. Here's how to improve your gas lift installations. Pt 1. Pressure at depth determinations. H. W. Winkler. *World Oil*, 1.8.59, **149** (2), 63.—In a gas lift installation it is essential to calculate accurately the injection gas pressure at depth. This can be determined from the equation:

$$P_v = P_w(e)\,\frac{GL}{53{\cdot}34\,T_{avg}Z}$$

where e = log base: 2·718; G = gas gravity (air 1); L = length of gas column, ft; P_v = gas pressure at depth, psia;

P_w = gas pressure at surface, psia; T_{avg} = average temp of gas column, °R; Z = compressibility factor for average pressure and temp of gas column.

Charts for solving the equation are included, together with a chart showing compressibility factors for natural gases. Examples are given. C. A. F.

1530. Good injection water at minimum cost. D. E. Hockaday. *World Oil*, 1.8.59, **149** (2), 72.—Costs of injection are influenced by the quality of injection water, which should be such that it can be injected at the required rate and that corrosion can be prevented or controlled for the required period. Because of differences in injection characteristics, due to variable formation factors such as permeability and reservoir pressure, all water floods should have an initial pilot trial. The effects of changes in mechanical handling and chemical treatment on injection well performance can be determined by: (1) plotting injectivity index *v.* time; (2) carrying out permeability and skin damage tests from pressure bleed-off analysis; and (3) plotting injection rates and pressures *v.* cumulative injection or time. Turbidity and scaling problems affect injection well performance, and three types of severe corrosion can occur: (1) bacteria induced; (2) low pH waters with hydrogen sulphide; and (3) sweet corrosion due to free CO_2 or O_2. Cathodic protection is an effective protection at nominal cost for tanks and filters, but the lines must be coated or solid plastic lines can be used. Four case histories of water treatment in water floods in Oklahoma and Texas are given. C. A. F.

1531. How to determine the contents of horizontal cylindrical tanks. M. H. Green. *World Oil*, 1.8.59, **149** (2), 83.—A nomograph is presented for calculating the vol of liq contained in horizontal cyl tanks which are commonly used in fields for temporary storage. They are not usually strapped for measurement, and field calculations from measurement tables may be complicated. The nomograph provides a simple means of calculating fluid contents for this type of tank, and an example is given of its use. C. A. F.

1532. How to control paraffin in separation equipment. W. L. Scheirman. *World Oil*, 1.8.59, **149** (2), 89.—The importance of designing separators so that paraffin wax deposition can be prevented is emphasized. Such deposits cause plugging of valves, discharge lines, and build-up within the separator, causing loss of separator capacity. In order to prevent deposition the separator must function above the temp of paraffin deposition, requiring a heating coil using steam or hot water in the liq section of the separator. Waxy crudes may form emulsions with the well water requiring special treatment. A type of system used offshore consists of two vertical separators and a steam heated vertical emulsion treater: one separator removes the gas, the water is then removed in the emulsion treater, and the second separator is used as a safety device. Diagrams illustrate the system. C. A. F.

1533. Oil recovery by thermal methods. 2. T. W. Nelson and J. S. McNiel, Jr. *Petrol. Engr*, March 1959, **31** (3), B75.—*In situ* combustion is a thermal oil recovery method where the energy required for moving crude oil through the reservoir and eventually into production well bore is created by injecting air into the reservoir and burning a portion of crude oil therein. The process is visualized as a slowly moving narrow burning zone which advances from the air injection well to the production well, moving oil ahead of it. As the burning front moves, a number of different but intimately related oil displacement mechanisms are believed to occur simultaneously. These are: (1) condensing steam drive; (2) gas drive; (3) miscible drive; and (4) thermal drive. The principal items to be considered in designing an *in situ* combustion operation are amount of air required, the rate of air injection, the air injection pressure, and the amount and rate of oil production. These items are discussed in detail in the paper.

The primary factors to be considered with regard to the economics of *in situ* combustion process are original oil content of the reservoir, percentage oil recovery, crude oil price, air compression costs, well drilling and maintenance costs, and lease operating costs.

A brief mention is made in the paper of the potential use of thermonuclear energy release as a means of producing oil not recoverable by conventional techniques. M. F. M.

1534. Metrage capacity and production of the German petroleum recovery industry in 1957. (In German.) H. Pfefferkorn. *Erdöl u. Kohle*, 1958, **11**, 228–31.—The metrage drilled in 1957—divided into wildcat, extension, production, and aux drilling—exceeded that of 1956. Figures are tabulated for regions and fields with comparative figures for 1956. R. T.

OILFIELD DEVELOPMENT

1535. Review of the principal discoveries in the past ten years. R. G. Levy. *Bull. Ass. franç. Tech. Pétrole*, March 1959, (134), 299–342.—67 discoveries have been made, 46 being oil finds. Reserves at the end of 1958 are estimated at 500×10^6 tonnes of oil and over 10^{12} m³ of gas. Reserves and production have risen steeply since 1956, mainly due to discoveries in Africa.

In Alsace some of the discoveries produce from sands as at Pechelbronn, but others produce from fractured limestones. In Aquitaine Saint-Marcet has produced $3{\cdot}5 \times 10^9$ m³ of gas, and has reserves of 3×10^9 m³. Lacq was found in 1949, and has produced 2×10^6 tonnes of oil. There are also gas reserves of 3×10^{11} m³, with 15% H_2S and 25 cc gasoline/m³. Parentis has 28 wells, and has produced $4{\cdot}7 \times 10^6$ m³ of oil, the reserves being 22×10^6 m³. Other finds have been Mothes, Lugos, and Lucats.

Three oil discoveries have been made in the Paris Basin, but their full extent is unknown. Impregnations have been found in a number of places.

Haricha was discovered in Morocco in 1957, its reserves being *ca* 750,000 tonnes. Gas has been found at Kechoula and Jeer. There have been several finds in Gabon by seismic reflection work. Production is from Eocene silicified clays and Upper Cretaceous lenticular sands; there is cap rock production at Alewana. All appear to be associated with salt masses.

Gas has been found in the Ordovician and Lower Devonian at Ahnet and Mouydir in the Sahara. 3–4% of He occurs in the gas at Meredoua. At Hassi-Messaoud the reserves are placed at 300–500 $\times 10^6$ tonnes of oil. A discovery has been made at El Gassi, 90 km to the SW. The reservoir may be of Cambrian age. Hassi-R'Mel has gas with 156 g of gasoline/m³, and recoverable reserves of 800–1000 $\times 10^9$ m³.

A table lists the fields, giving discovery date, mode of discovery, type of trap, depth, nature and thickness of reservoir, area, producing mechanism, number of wells, cumulative production, 1958 production, and reserves. G. D. H.

1536. California's hottest gas area is getting hotter. F. B. Loomis. *World Oil*, 1.8.59, **149** (2), 96.—There is intensive drilling activity in the Sacramento Basin in N California, where there are now 40 producing gas fields with a 1958 production of 115,692 MMcf. Reserves are estimated at *ca* 2·1 trillion cu ft, or 18 years' supply at the current producing rate. The gas is dry, and industrial growth has provided a high demand. Future market prospects are excellent, drilling is simple, and wells have a long producing life. Systematic exploration is very difficult because of complex subsurface geology, and success depends on imaginative analysis of structural and stratigraphic factors. C. A. F.

1537. Independents do much of the drilling in all areas. L. J. Logan. *World Oil*, July 1959, **149** (1), 110.—Over 6500 independent operators and smaller companies drilled *ca* 80% of all wells in the U.S.A. in 1958, *i.e.* 38,500 wells out of a total of 48,341 in the country. Most of these were in New York, W Virginia, Ohio, Kentucky, Indiana, Michigan, and Alabama, where wells are generally shallow, drilling costs are moderate, and production is small. A table shows activities of independent operators in the U.S.A. in 1958. C. A. F.

1538. Puget Sound area has several prospective oil and gas basins. J. Q. Anderson. *World Oil*, July 1959, **149** (1), 111.—There are good possibilities of significant oil and gas reserves in the Green River district near Puget Sound in NW Washington State. There are ready markets, but no commercial fields have yet been found, although in recent years there has been active drilling and shows of high gravity oil have been found in sands. The geology of the area is described; there are several basins containing Tertiary and Upper Cretaceous marine beds. Surface mapping and geophysical work is complicated by dense vegetation and glacial drift; false anomalies have been met due to iron-rich basalt boulders in the drift. In the Green River district there are a series of parallel folds on the E and W flanks of an anticlinorium and potential source and reservoir rocks occur. Only one of the folds, the Kummer anticline, has been drilled, and closure is not proven. Core drilling to obtain evidence of closure in the structures is recommended. Five refs.
C. A. F.

1539. Developments in Eastern Canada in 1958. D. Jardine and B. V. Sandford. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1419–26.—In E Canada an area of *ca* 80,000 sq miles is underlain by marine sedimentary rocks which offer some possibility of yielding oil and natural gas. These sedimentary areas occur throughout the provinces of Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, and Newfoundland. Small quantities of oil and gas have been found throughout most of this region, but fields of commercial significance were found in only two districts—the SE part of New Brunswick and SW Ontario.

In SW Ontario 99 exploratory and 255 development wells were completed during the year. Natural gas production increased by 7% over 1957, and oil production increased by 24% to 778,341, giving the highest production since 1907.

In the remainder of E Canada activity continued at a high level. 18 exploratory wells were completed—a decrease from 27 in 1957—but the total of footage drilled was up slightly over the year. E. N.T.

1540. Developments in Western Canada in 1958. C. A. S. Bulmer. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1406–18.—Developments in the exploration for oil and gas in W Canada in 1958 show a decrease of 19% from 1957, the number of exploratory and development wells completed being 2436. Decreases in both exploratory and development drilling were noted in all areas with the exception of Alberta, where a slight increase in the number of development wells was recorded. The most promising discoveries were made in Alberta and NE British Columbia in sediments of Devonian, Mississippian, and Triassic age.

Gas deliveries to Ontario and Quebec began as the Trans-Canada pipeline completed its last stage.

Continued interest in the Yukon and NW Territories was evident as the result of a major land play which developed in the early spring. E. N. T.

1541. Developments in Alaska in 1958. H. Mann. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1427–36.—Exploratory activities increased significantly in 1958, largely as a result of the discovery of oil on the Kenai Peninsula in the latter part of 1957. Surface and geophysical mapping increased 500% and 400% respectively, being conducted by 15 oil companies in nine areas.

Drilling increased slightly with 12 wells active at various times. The total footage decreased from 52,480 in 1957 to 47,578 in 1958. As at 31 Dec there were five drilling wells in Alaska.

Leasing has been intensive with more than 40 million acres filed upon at the end of 1958, compared with *ca* 10 million acres at the end of 1957. E. N. T.

1542. Petroleum developments in South America and Caribbean area in 1958. E. W. Clark. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (7), 1518–80.—Oil production in S America and the Caribbean during 1958 was 1,120,800 brl or 3,071,100 bd, compared with 1,169,200 brl or 3,202,700 bd during 1957. The reduction was due mainly to a decrease of 174,000 bd in Venezuela. Production in Brazil was nearly doubled from 27,700 to 51,800 bd; small gains were noted in Argentina, Chile, Colombia, and Trinidad. The total number of wells drilled in the area amounted to 2418, compared with 3074 in 1957, the decrease being mainly due to the reduction in drilling in Venezuela.

Among the new developments were the re-opening of Argentina to foreign investment in the petroleum industry, and an increase in income tax in Venezuela resulting in a substantial increase in the Government's share of oil company profits.

It has been stated that there would be no more oil concessions granted in Venezuela and exploration activity was being reduced at the end of the year.

In Argentina contracts calling for very substantial capital expenditure during the next few years have been signed with a number of foreign oil and financial organizations. E. N. T.

1543. Petroleum developments in Mexico in 1958. E. J. Guzman. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1505–17.—Exploratory activities in the search for petroleum and gas in Mexico during 1958 continued to be concentrated mostly within the known oil-producing sedimentary basins along the coastal plain of the Gulf of Mexico. 379 wells were completed, as compared with 389 drilled during 1957. The average depth per well increased from 6463 to 6958 ft for a total footage of 2,636,900 ft, an increase of 122,735 ft over 1957. 76 wells were classified as exploratory holes, 17 of which were successful (22%). 55 new-field wildcats were drilled, and new reserves were added through the discovery of four new oil and/or gas fields, 12 new pools, and one extension to a previously producing field. 285 (75%) of the total wells were successful.

Two new gas fields were located in NE Mexico; one oilfield was found in the Poza Rica district, and a fourth field in Central Tabasco in S Mexico.

The bulk of the exploratory effort was concentrated in the coastal plain of the Gulf of Mexico, but gravity and seismic work continued in other areas. Production in the Isthmus and Tabasco region increased 7000 bd.

Crude oil and dist production for 1958 was 100,641,405 brl. Total gas production was 262,626,152 MCF—an increase of 8·5 million brl of oil and *ca* 100 million MCF of gas.
E. N. T.

1544. Petroleum developments in Middle East and adjacent countries in 1958. H. Hotchkiss. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (7), 1676–713.—Exploratory effort remained generally high during the year; exceptions were Israel and the Yemen, where a decrease in effort was noted. Two exploratory wells rated as indicated discoveries in Saudi Arabia during 1957 were officially completed during 1958. An indicated discovery of potential importance was made in the Abu Dhabi offshore area of the Trucial Coast. A discovery was recorded in N Kuwait. An indicated gas discovery was

made in the N Negev, Israel. Two small oil discoveries were made in Turkey.

Production in the Middle East countries totalled 1,559,533,000 brl, an average of 4,272,884 bd, which compares with a total production of 1,293,399,000 brl in 1957, an average of 3,670,432 bd. Pakistan production totalled 2,271,379 brl, an average of 6209 bd, which compares with a total production in 1957 of 2,205,000 brl, an average of 6041 bd. Production in India is estimated to have totalled 3,102,500 brl, an average of 8500 bd.

Important new concessions were granted by Iran in the offshore area near the head of the Persian Gulf, and by the Ruler of Kuwait in the offshore area of the Kuwait–Saudi Arabia Neutral Zone. Two concessions were cancelled—one in Syria and one in Iraq. E. N. T.

1545. Geophysical parties work in marshes in South Iraq. Anon. *World Oil*, July 1959, **149** (1), 121.—Extensive geophysical work is being carried out in the marshes of S Iraq, necessitating the use of various types of waterborne and amphibious craft, such as airboats, rafts, and marsh buggies; these have facilitated transport. Work started in the area in 1957, and in 1958 operations were being carried out in the Hor Al-Hawizeh, a swamp adjoining the Persian frontier. Previous seismic work in S Iraq led to the discovery of the important Zubair and Rumaila fields near the Kuwait border. C. A. F.

1546. Petroleum developments in Africa in 1958. H. D. Hedberg *et al. Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (7), 1625–75.—Petroleum exploration, development, and production activities in Africa reached new all-time highs in 1958 with the production of 31,930,880 brl of oil representing an increase of 72% over 1957. Egypt alone recorded a 33% increase and still dominates the production picture. Egyptian production, however, represented only 69% of the Africa total in 1958, in contrast to almost 90% in 1957. Gabon, Algeria, and Nigeria were largely responsible for this change.

141 exploratory wells were completed in 1958, of which 18% were successful. Eight discoveries were reported from Nigeria, six from Algeria, four from Libya, three from Gabon, two from Egypt, and one each in Angola and Morocco. Exploratory wells were completed but without success in Cameroun, Congo, Madagascar, Senegal, Somalia, British Somaliland, and Tunisia. 191 development wells were completed during the year, 74% of which were successful; a total of 2,214,392 ft of hole was drilled in 1958, and at the end of the year 90 rigs were in operation. E. N. T.

1547. Petroleum developments in Far East in 1958. G. F. Kaufmann. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (7), 1714–32.—The only news of oil discoveries and important increases in production in the Far East during 1958 comes from Communist China, where discoveries of crude oil in important quantities have been reported from the Szechwan province in Central China. Japan has increased its production by 800 bd, an increase of 13% in Japanese indigenous crude oil production. A rise in the daily average production in Indonesia has been almost offset by a decline in production in British Borneo. A gas discovery in the Philippine Islands in the Cagayan Valley, N Luzon, may have to be classed as non-commercial because of quantity and remoteness of location. Gas discoveries in Papua must also be classed as non-commercial for the same reasons, but the small discovery of oil in Puri No. 1 in Papua remains to be evaluated.

News releases from Russia indicate that many exploration parties were active throughout E Siberia as far as the Pacific Coast, and that exploration over the W Siberia platform and basin areas, E of the Urals, has been carried on with increased intensity. E. N. T.

1548. Non-commercial discovery may forecast oil in Papua. Anon. *World Oil*, July 1959, **149** (1), 118.—Puri No. 1, *ca* 250 miles NW of Port Moresby in Papua, discovered oil in Nov 1958. This was the first successful well out of 19 wildcats drilled in the country, but after the production of 3500 brl there was rapid decline with salt water incursion. Pay was limestone at *ca* 7500 ft. A comprehensive search has been carried out in Papua for many years; aerial photographs, geological and geophysical work have been carried out, but exploration is hampered by thick jungle. Helicopters have proved very useful for transport in these conditions, with considerable savings in costs. C. A. F.

1549. Petroleum developments in Europe in 1958. R. E. King. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43** (7), 1581–624.—In W Europe oil production rose from 83,865,454 brl in 1957 to 86,841,463 brl in 1958, an increase of 3·5%.

German production increased more than 12%, Italian and Yugoslav both by 13%, and Dutch by 6%, while Austria showed a marked decline. In France the first commercial production was obtained in the Paris Basin, with four new fields, three producing from the Jurassic and one from the lower Cretaceous. Natural gas production increased from the large Lacq deep gas field in SW France, but oil production declined slightly. In NW Germany an important oil discovery was made in a stratigraphic trap E of the Emsland fields and a significant new field was found in Holstein, SE of Kiel. The greatest exploration success ratio was in the Molasse Basin N of the Alps—two oil and five gas fields being discovered. In Italy natural gas production increased only 2%, but two apparently significant new gas fields were discovered in the Po Valley. A new heavy oil field was found near the Gela field in S Sicily. In the Netherlands production declined in the large Schoonebeek field in the E part of the country, but this was offset by increases in the Rotterdam–Hague region, where two minor oil and one gas discovery were made. In Yugoslavia important discoveries in Croatia indicated that major production increases could be expected in 1959. The first deep exploratory well was started in Malta; an oil concession was granted to an American company covering all of Eire; and in the U.K. oil production declined slightly, but a new oilfield was found in Carboniferous sands in the Midlands and two minor oil and one gas discovery were made.

Active exploratory drilling continued, but without success, in Denmark, Spain, Portugal, and European Turkey. E. N. T.

1550. Petroleum exploration of 1957 in West Germany. (In German.) F. Kühne. *Erdöl u. Kohle*, 1958, **11**, 217–28.—A regional survey of petroleum exploration in 1957 in W Germany with maps and extensive tabulations. Details of geological formations, extended wells—successful and closed as unsuccessful—not reaching the Thuringian, and not yet closed. R. T.

1551. Netherlands oil yield fills fourth of national demand. Anon. *World Oil*, 1.8.59, **149** (2), 92.—Eight oil discoveries have been made between The Hague and Rotterdam since 1953, and E of Rotterdam there has been important development in the Ijsselmonde–Ridderkerk area, where the Ijsselmonde field produced an average of 1865 bd in 1958. The Schoonebeek field in E Holland produced only 71% of Dutch output in 1958 compared to 100% in 1952. Exploration is continuing and may extend offshore into the North Sea. Seven gas fields, all moderate or small in size, have been found, and reserves are sufficient to guarantee a 20-year supply at a rate of 19,415,000 cu ft/day. C. A. F.

1552. Search for oil in France. J. de Ratuld. *Bull. Ass. franç. Tech. Pétrole*, March 1959, (134), 273–96.—Before the war, apart from the long-standing Pechelbronn production,

France had only been able to develop some gas production at Saint-Marcet–Saint-Gaudens, and some oil production in Morocco.

In 1945 the Bureau de Recherches de Pétrole was set up, and subsequently a number of companies were formed with State participation. In 1951 and later foreign companies were able to obtain exploration permits in France and overseas. Oued Beth in Morocco was discovered in 1948 and Oued Gueterini in Algeria in 1949. Lacq was opened in 1950. Parentis was found by Esso in 1954. About the same time dry gas in quantity was found in the Sahara, where conditions were very difficult.

After 1954 new legislation made conditions better for financing exploration. Edjeleh, Ozouri (Gabon), Hassi Messaoud, and Hassi R'Mel were found in 1956. These discoveries encouraged the creation of new companies for operations in France and overseas. In 1958 legislation for the Sahara arranged for equal sharing of the profits between the company and the Territory. Service companies were formed, and training facilities were increased.

In 1958 it was possible to ship 440,000 tonnes of oil from Hassi Messaoud. Plans were made for a 60-cm dia pipeline to Bougie, with tanks at that point. A similar line is planned for Edjeleh to be completed in 1960.

Additional companies have entered the field by the surrendering of the required proportions of the early concessions.

Some figures are given on investment, equipment, manpower, and production, for the present and the future in some cases. G. D. H.

1553. Petroleum technology in the U.S.S.R. I. S. Salnikov. *World Petrol.*, April 1959, **30** (4), 43.—It is hoped to increase oil production in the U.S.S.R. to 4,800,000 bd by 1965, and most of this will come from newly discovered fields in the Ural–Volga region, which produces 77% of Russia's oil. In recent years the steady increase in production has come from continuous exploration rather than spectacular finds such as occurred in the old Baku fields. Technical developments in drilling and production methods are described; the turbodrill is now used for 88% of all wells, and research is going on to develop smaller turbines. The slim hole technique has been tried in order to reduce drilling costs, and other types of drills, such as the electrodrill and bit-less drills using flame disintegration, are being investigated. Production practices are similar to those in the U.S.A., and because there are no ownership problems there are no problems in well spacing for production control. Contour water flooding has been reported successful, and in the Ural–Volga region water injection is applied before reservoir pressure has fallen below the optimum required for most efficient operations. Production wells in this area are usually drilled on 50–150-acre spacing. Gas injection for pressure maintenance appears to be rare, but gas lift is used for *ca* 5% of total production. Automation is being applied to the industry. C. A. F.

1554. Why the oil industry needs a depletion provision. Anon. *World Oil*, July 1959, **149** (1), 120.—A 27·5% depletion provision is essential for economic investment in the U.S. oil industry. Drilling costs and operational expenses have steadily increased in recent years, due mainly to increased offshore work, deeper drilling, and higher costs of labour and materials. In 1956 the average cost of an offshore well was $415,000 compared to $50,200 for wells drilled in other areas. The average cost per ft drilled increased from $11.03 in 1954 to $12.35 in 1956. Costs increase very rapidly as drilling depth increases; in 1956 the average cost of 14,006 wells not deeper than 3750 ft was $26,500, but for 150 wells over 15,000 ft deep the average cost was $761,700. C. A. F.

TRANSPORT AND STORAGE

1555. Requirement and production of welded steel tubes for pipelines. (In German.) K. Wallmann. *Erdöl u. Kohle*, 1958, **11**, 244–7.—Operative procedure for producing welded steel tubes for pipelines is described with numerous illustrations of the mechanical operations. The steels used are mentioned and their respective properties are explained. Stresses undergone successfully by the steels in the pipelines after welding, and suitable aftertreatment are discussed. The throughput of oil, natural gas, or mineral oil could be increased by using high-grade steels, thus lowering the expenditure. R. T.

1556. Pipeline costs. R. Reed and G. Kinney. *Oil Gas J.*, 13.7.59, **57** (29), 89.—Six articles come under the above heading in a special section. The first shows that operating costs of oil line operation have dropped 23% in ten years, whilst the second indicates an increase in gas line operation costs.

Rules of thumb for estimating pipeline costs are given, short cut methods having been selected from current pipeline practice.

The fourth article shows that there is no average or typical construction costs for pipelines or compressor stations; each area requires a separate study.

The fifth article shows that labour and equipment costs have risen to *ca* 30% in the period 1954–59, and the final article tabulates typical crude and products rates, showing that pipelines are still the cheapest overland form of transport.

G. A. C.

1557. Remote control of a large single-unit gas turbine compressor station. P. Reed and G. Kinney. *Oil Gas J.*, 29.6.59, **57** (27), 74.—Texas Eastern Transmission Corpn on its Penn–Jersey system is remotely operating four single-unit stations each powered by a 13,400-hp gas turbine driving a two-stage centrifugal compressor at 4860 rev/min.

A fire-resistant lubricant is used (a synthetic phosphate ester-based product) in a closed system. The closed water-cooling system maintains lubricant at correct operating temp. Fuel gas is taken from a 3-inch tap or a 30-inch suction line and reduced to 175.

Remote control is by means of four metallic leased-wire circuits, one pair carrying actuating signals, the other alarm and telemeter information. Surge is controlled by a station recycle valve which operates automatically. If ac power fails all instruments automatically operate on an inverter which runs off a 125-V nickel–cadmium battery. G. A. C.

1558. Chromed machine parts last longer. D. Haack. *Oil Gas J.*, 6.7.59, **57** (28), 136.—Mid-Continent Pipe Line Co chrome plates many components of pipeline machinery, including engine-cyl and reciprocating pump liners, engine and pump crankshafts, piston rods, crosshead pins, and camshafts, with beneficial results. Engine thermal efficiency is increased following plated liners, and life of plated parts increased.

G. A. C.

1559. Bolivian line extends across Andes to Pacific port. E. E. Mincheff. *Pipe Line Ind.*, July 1959, **11** (1), 52.—The 215-mile crude oil line from Sicasica over the Andes to Arica in Chile. The capacity is 7000 bd and can be increased to 50,000 bd. Part of the line is at an altitude exceeding 14,000 ft, and for this part all pumps, engines, and compressors had to be derated to 70% of their sea-level rating. The final stretch of line contains a very steep drop of 12,000 ft. The overall static head is 4792 psi. The steep section is

equipped with automatic pressure reducing stations which, as well as controlling the pressure, can shut down the line in case of breakage. The terminal has a scraper trap, pressure-reducing station, and four tanks totalling 300,000 brl. It can be isolated from the incoming line by a gate valve. Tankers are loaded at a sea berth. Ballast water is handled at a separately located pit which can be connected to the sea line. G. B.

1560. Flow tests on internally, in-place coated pipe. C. H. Klohn. *Pipe Line Ind.*, July 1959, **11** (1), 36–45.—Flow tests are reported on an 11·9-mile stretch of 24-inch natural gas line. The line had been in use carrying dehydrated gas for 10 years without cleaning. Flow tests, calibrated by the ammonia displacement technique, were made before cleaning, after running two wire brush pigs and after cleaning with MEK and coating internally with epoxy resin. Modifications to the generally used flow equations are proposed. Cleaning produced a 4% increase in flow, and coating produced a further 1–6% increase, depending on the flow rate. G. B.

1561. How fully integrated control systems work. W. F. Haley. *Pipe Line Ind.*, July 1959, **11** (1), 46–51.—In the pipeline control system described, both the data from the field stations and the controlling signals from the office are transmitted as a pulsed code. Data signals from transducers at the field stations are converted by a servo motor and commutator into binary code. At the office the pulses are decoded and presented as decimal digits either on a digital indicator or by typewriter. The capacity of the system is 35 addresses, each sending five 3-decimal-digit data signals or five 3-position control signals (*e.g.* open–close–stop) in addition to identifying signals. The control signals are made by push-buttons. The system is continuously self-monitored for faults, and no fault can initiate a control or data signal. G. B.

1562. Communications applications broadened by new microwave techniques. I. T. Corbell. *Pipe Line News*, 1959, **31** (7), 42.—Various microwave transmitting and receiving equipments used in communications are described in the paper. They include the UA-6-A frequency-modulated type equipment, which operates in the 5·9–7·4-KMC frequency band, and the UA-1-D type system, which is pulse modulated and operates in the 1700–2000-mc frequency band. Both UA-6-D and UA-1-D equipments have optional provisions for diversity —either space reception or frequency. If microwave is used for transmitting high speed signals (such as protective relaying) it is necessary that the signals from the two receivers be combined without switching to prevent "hits." UA-1-D can be used as a dual-beam system. Selection of the best combinations of equipment for a given application requires careful analysis of the system requirements, and these are briefly discussed in the paper. M. F. M.

1563. Italy advances in pipeline telecontrol. F. V. Long. *Pipe Line News*, July 1959, **31** (7), 22–9.—This paper is a discussion of a paper presented by Raffaele Girotti and three other Italian authors during the Fifth World Petroleum Congress and covers four general areas of interest. (1) Description of an automatic cathodic protection system. (2) Events leading to the use of automation and telecontrol in Italy. (3) Description of a telemetering communication link using the pipeline as a transmittal medium. (4) Description of a transistorized computer system for pipeline control in Italy. M. F. M.

1564. The pipeline spheroid—an effective technique for fluid separation. Pt II. M. L. Barrett, Jr. *Pipe Line News*, July 1959, **31** (7), 30.—This is the concluding part of the paper describing the mechanics of automatically by-passing a pumping station by use of pipeline spheroids. The outstanding potential of spheroids lies in the economics of pipeline operation which they can effect. The proper use of multiple spheroids, particularly in large dia pipes, is an effective method of controlling and reducing the interfacial mixing of continuous flowing fluids. The spheroid has proved to be a very satisfactory means of displacing or evacuating a fluid from a pipeline. It is more economical to operate than the "dumb-bell" type scraper and has a much longer life. M. F. M.

1565. Rubber balls clear water from line. L. Brooks. *Oil Gas J.*, 3.8.59, **57** (32), 112.—Inflatable rubber spheroids, with walls 3 inches thick, and with dia before inflation slightly less than that of id of pipe to be tested, have been successfully employed in hydrostatic testing of several hundreds of miles of pipelines in Florida. Air locks are prevented by maintaining a solid water column throughout filling, testing, and emptying operations. Advantages of use of the balls included reduced compressed air requirements, tight seals, and large reduction in air locks. G. A. C.

1566. Pipelining at 30 below. J. S. Black. *Oil Gas J.*, 17.8.59, **57** (34), 136.—Cold weather hazards in Saskatchewan, Canada, which includes, as well as temp 30° F below zero, even a reading of 40° F below, call for special clothing, equipment, and techniques.

Company vehicles are equipped with a survival kit, including emergency food rations, sleeping bags, and gasoline stove; two-way radio is fitted.

A bunkhouse at the Cantuar pump station is maintained with provisions and accommodation for several men for two or three days during blizzard conditions.

Oversize motors and engines largely take care of congealing oil; ice crystals formed from water in oil in pipelines 3 ft below surface but still within frost line cause pressure build-up; regular scraper runs in summer are made to free line of water.

New construction and maintenance are carried out as far as possible in summer. G. A. C.

1567. Practical way to make a line cut. R. L. Brust. *Oil Gas J.*, 17.8.59, **57** (34), 220.—Unique use of a "line-stopper" or "stopple" is described to minimize problem of safe fluid disposal on cutting a natural gas pipeline which had to be relocated in or near city streets. This device permits a temporary line block to be made at any point without opening pipeline to atm, and is supplied in two pieces which are welded together on the pipeline like a split T with a flange where nozzle should be. After water displacement to reduce vapour hazard, the pipe is drilled through top and bottom and stopper device inserted, line bled off, and desired operation, in this case moving a valve some 200 ft, carried out, the stopper is then removed by reversing installation process. G. A. C.

1568. Electric surface heating of storage vessels. J. Carmichael. *Fluid Handl.*, 1959, 64–7, 81, 98–101.—Heat losses from rectangular steel storage tanks can be calc by given eqn if val of coeff K is known; table of K at various storage temp and wind speeds is given. Graphs are given for calculating heat losses and consequent rating of elec surface heaters necessary for heat compensation on bare cyl tanks up to 35 ft long. Effects of lagging and of geometrical shape of vessel are discussed. Description is given of Isopanel surface heaters and their advantages outlined. An alternative is an outflow heater, the tank being fitted with a baffle to reduce convection; eqn are given for calculating the loading required. Pipelines can be heated by Isotapes. Graph is given relating load in W/ft run to bore ($\frac{1}{2}$–5 inches) at temp differentials up to 200° C. Heaters are also available for valves; graph shows loading for flanged valves ($\frac{1}{2}$–6-inch bore) of average dimensions at differentials up to 200° C. W. A. M.

1569. Special applications of petroleum products pipelines. S. A. E. Walker. *J. Instn Engrs, Australia*, 1959, **31**, 155–61. —The design, laying, and operation of submarine unloading

lines to offshore tanker moorings in Australia are described. A typical layout of moorings for 16,000-ton tankers is shown. The line was welded and coated on shore with primer, pitch primer, and a coat of pitch enamel, floated out to the moorings on drum floats, and sunk into position. Anodic protection was provided. The line ends with an 8-inch flexible hose of Buna B rubber which has an expected life of 7 years, a working pressure of 100 psi, bursting pressure of 1000 psi, and permissible tension of 5 tons. A lifting cable is secured to a blanking flange and to a mark buoy. Under-sea lines are not heated. Viscous products are kept flowing by control of the initial temp and rate of discharge, and the line is cleared by a pig after each operation. Tanks and delivery lines ashore are lagged and steam heated. Precautions taken in the construction of the line to ensure the free running of the pig are described. G. B.

1570. Central hydraulic power systems for power operation of pipeline valves. Pt 3. H. A. Altorfer. *Pipe Line News*, Aug 1959, **31** (7), 45.—It has long been the desire of gas transmission companies to regulate gas pressure and large flows by means of plug valves. Regulating operation, however, has not been so far very successful. The newly developed Shafer Regulating Control with Gas–Hydraulic Pressure Generator shows considerable promise. This type of control, first built on a 30-inch plug valve, is briefly described and diagrammatically illustrated in the paper. M. F. M.

1571. Design and operation of dual beam microwave system. G. V. Morck. *Pipe Line News*, Aug 1959, **31** (7), 52.—In the successful operation and performance of any type of microwave system the function of standby microwave equipment assumes a primary and vital role in reducing outage time to a negligible factor. Considerable advances in this direction have been made in recent years. An advanced design is claimed to have been achieved by Federal Telecommunication lab and is commonly known as "Dual Beam" microwave operation. The system has been in use by the Sinclair Pipe Line Co since Sept 1936, and an average reliability of 99·932% has been obtained over this period.

The "Dual Beam" microwave system is two separate microwave systems operating on a single microwave frequency, and it works because it is possible to separate the vertical and horizontal polarized radio waves of a single microwave frequency. This separation should be of the order of 20 db or more for optimum operations. The paper describes the system in some detail and discusses some of the data obtained from its operation. M. F. M.

1572. Pumping solids through pipelines. J. Nardi. *Pipe Line News*, Aug 1959, **31** (7), 26.—Successful pumping of solids through a pipeline is generally more difficult than the pumping of fluids. Large lumps can be transported for short distances if the sp gr of the solid is not much greater than the slurry. Small size solids can be transported successfully over long distances in suspension.

Chemical additives are essential for solid transportation to minimize corrosion and erosion, keep the solids in suspension, separate the solids from the continuous phase at the terminal, and clean and purify the effluent. A pipeline is more economical than the usual means of bulk transportation, such as barges, rail transport, etc., only when: (1) large quantities; (2) very long useful life; (3) high annual load factor; and (4) relatively long distances are involved. The cost of preparing the slurry for pumping and dewatering it at the terminal often exceeds the cost of transportation.

Pipeline transportation has two basic advantages over rail and road transport. First, a small proportion of its costs are in labour and materials, and secondly, the cost of returning the empty container is eliminated.

The paper traces the history of pipeline transportation of solids and describes some large-scale commercial plants which utilize such systems. M. F. M.

1573. Comparing calculated flow with actual pipeline flow. J. B. Capdeville. *Pipe Line Ind.*, Aug 1959, **11** (2), 35–40.—Flow formulæ proposed by different authors are compared. Experiments carried out at the Hydraulic Institute at Chatou and on the Havre–Paris products line agree best with the results of Colebrook (*J. Inst. Civ. Engrs*, 1939). The relative rugosity of the pipe decreased from 0·0002 to 0·0001 with use. G. B.

1574. A new approach to pressure surge analysis. R. D. Kersten. *Pipe Line Ind.*, Aug 1959, **11** (2), 46–51.—The pressure waves produced in a pipe system by reciprocating pumps have been analysed by the techniques used in the electrical analogue. Predictions are in agreement with experiment. G. B.

1575. Continuous fluoroscopic inspection of line pipe. A. B. Wilder and E. B. Henry, Jr. *Pipe Line Ind.*, Aug 1959, **11** (2), 26.—With the apparatus described the longitudinal seam of welded pipe can be examined at the rate of 20′/hr. An X-ray head with a choice of focal spots of 0·4 mm and 2·5 mm, rated at 150 kV const potential and 3 mA and 12 mA, is mounted on a boom passing through the pipe. The image produced by an image intensifier is viewed through a binocular optical system from a screened booth from which the operator can also control the pipe carriage and adjust the X-ray generator, head, and fluorescent screen. Contrast sensitivity of 2% is achieved. TV image conversion does not as yet give as good resolution. G. B.

1576. Oil tank sites preloaded by well point system. R. F. Scott. *Engng J., Montreal*, Aug 1959, **42** (8), 79–83.—On sites at Fort William chosen for the erection of storage tanks the soil consists of compressible clay covered by 24 ft of silty sand with a high water table. Settlement was induced before construction by preloading. The water table was lowered by 20 ft by pumping from a ring of wells round each tank site. At the same time gravel was added to a height of 10 ft. This was removed to leave a 4-ft bed of gravel when the tanks were constructed. The further settlement of the tanks when filled agreed well with the predicted values. Construction of the tanks was begun two months after the preloading was applied. G. B.

1577. Install flow controls and use laterals for gas storage. J. A. Bonner. *Pipe Line Ind.*, Aug 1959, **11** (2), 44–5.—By fitting a max flow controller at the transmission line tap, set at the contractual flow rate, and a by-pass set to open at a lower down-stream pressure, the pressure in a long lateral line can be allowed to fall to provide gas for peak demands without taking gas at excess rate from the transmission line. G. B.

1578. Underground gas storage at Lussagnet. J. Socrate. *Rev. Inst. franç. Pétrole*, Jan 1959, **14** (1), 72–9.—Underground gas storage at Lussagnet aims at ensuring continuity of supply in SW France when the Lacq processing units are closed for overhaul. This structure was selected after five reasonably placed structures had been examined from this point of view. It has a thick sand aquifer of 3–4 darcys permeability. Seismic work and some drilling had been done in the search for oil. 300–400 m of impermeable rock was found over 45 m of reservoir rock on a NW–SE anticline. A 22-km long, 15-cm pipeline was laid from Lussagnet to Mazerolles to join the 35-cm Lacq–Langon line, and other installations were built. By April 1959 it was possible to inject 2–5 $\times$ 10^6 m³/day to give a total stock of 400 $\times$ 10^6 m³ plus the cushion. Steps have been taken to prevent hydrate troubles.

On the whole it appears that the project will prove satisfactory, but not all uncertainties have been removed yet. G. D. H.

1579. Effect of unsteady-state aquifer motion on the size of an adjacent gas storage reservoir. D. L. Katz, M. R. Tek, and K. H. Coats. *J. Petrol. Tech.*, Feb 1959, **11** (2), AIMME Tech. Paper No. 8049, 18–22.—Van Everdingen and Hurst's theory of unsteady-state flow in porous media has been applied to predict the water flow into and out of a gas storage area for several pressure cycles such as would arise from alternating injection and production for a gas bubble in a very large aquifer. Uniform porosity and permeability were assumed, as well as the absence of capillary and gravitational effects. An IBM-650 digital computer was used for the calculations.

For cycles with as many pound-days above as pound-days below the original aquifer pressure the gas reservoir vol may grow or shrink slowly, rather than stay at a fixed value.

Theoretical predictions are compared with observations for an actual gas field. G. D. H.

1580. Expansion at Thames Haven. Anon. *Fluid Handl.*, 1959, 161–6.—Facts, figures, and pictures illustrate expansion at Thames Haven since 1948, especially during 1957–59. New tankage, jetties and berths, pumps and pipelines have increased capacity to $1{\cdot}75 \times 10^6$ tons. Imports in 1958 were 6×10^6 tons. Modern loading facilities enabled $4{\cdot}2 \times 10^6$ tons of refined products to be delivered in 1958. Further expansion is in progress. W. A. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1581. A symposium on cyclones. H. A. Leniger. *Ingenieur, 's Grav.*, 17.7.59, **71** (29), Ch 31.—An introduction is given to a group of lectures on cyclones. The use of cyclones to separate solid/solid, solid/liq, solid/gas, liq/liq, and liq/gas systems are discussed and compared with the more conventional means of separation. The advantages and disadvantages of cyclones are mentioned, and it is concluded that cyclones are best suited for solid/gas, liq/gas, and liq/liq systems.

D. C. E. deW.

1582. Direct-contact interstage cooling. W. S. Stewart and R. L. Huntington. *Oil Gas J.*, 6.7.59, **57** (28), 96.—By cooling natural gas between compressor stages through direct contact with water, large savings appear possible both in power and heat exchange costs.

Work was carried out at the University of Oklahoma to obtain values for heat and mass-transfer coeff for a 6-inch × 10 ft perforated plate column when operated as a direct-contact cooler, and to determine the effect of four variables, liq and gas flow rates, gas temp (140°–240° F) and column pressure (1–5 atm) on the coeff.

Values for overall heat transfers for gas-film and liq-film and overall or gas-film mass transfer coeff have been calculated from the experimental data. The overall and liq film heat transfer and the overall mass transfer experiments were found to be functions of gas-flow rate and column pressure and independent of the liq-flow rate and inlet-air temp.

Gas-film transfer coeff was a function only of air-flow rate.

The data show that in all cases in the study the major mode of heat transfer was by convection; the heat transferred by evaporator did not exceed 30% of the total at the lower pressure; it was negligible at high pressure.

Gas film was major resistance and liq-film resistance was not negligible at low pressures, particularly up to 3 atm pressure.

It is estimated that direct cooling would save $24,000/million scf/hr for compressor investment alone at $300/hp.

G. A. C.

1583. Gas turbine heat can be profitably recovered. I. G. Rice. *Oil Gas J.*, 29.6.59, **57** (27), 66.—As a result of its operation, the gas turbine exhausts large quantities of highly preheated gas. A description is given of heat recovery systems.

Supplementary firing will decrease the excess air of the turbine exhaust, since the gas contains *ca* 80% of the original oxygen content of the air. The supplementary firing can be done in boilers or process heaters, examples being waste-heater boilers, cascade waste-heat and fired boilers, by-pass boilers, and fully exhaust fired boilers.

A graph displays estimated gas turbine heat recovery using a 7500-hp SC-1S gas turbine for 80° F ambient, sea level, 4-inch H_2O inlet drop, 8-inch H_2O back pressure, methane fuel and 3% heat loss, and balances are calculated for four examples of recovery systems. G. A. C.

1584. CO boiler supplements refinery steam supply. H. H. Forgey and T. E. Kobett. *Oil Gas J.*, 13.7.59, **57** (29), 138.—A CO boiler is described, designed and constructed by Stearns-Roger Manufacturing Co and installed for operating on the regenerator flue gas from the fluid cat cracking unit for use at Sugar Creek refinery of Standard Oil Co (Indiana).

The unit consists of an outdoor heat recovery steam generating unit, the flue gas from the regenerator being supplied to a cyl water-cooled furnace where refinery gas or oil is also burned to maintain a minimum furnace temp of 1500° F to ensure stable ignition of the CO bearing gas. The unit can generate a max of 250,000 lb/hr of steam, and where flue gas is not available the supplementary firing rate can be increased to produce a max of 201,000 lb/hr of steam.

A progress report (*ibid*, p. 143) lists 34 boilers operating or building for fluid or Houdriflow cats. G. A. C.

1585. Use of joints in petroleum industry. A. Conget. *Bull. Ass. franç. Tech. Pétrole*, 1959, 429–42.—Review: metal plastic, corrugated metal, metal cross band, metal annular, spiral, circular, and moulded. Advantages of size standardization stressed. (Author's summary.)

1586. Digital computer makes refining largely predictable for Tidewater. H. F. Lindsay and R. H. Wulzen. *Oil Gas J.*, 27.7.59, **57** (31), 177.—Programmes for rapid calculation of refinery yields and profits on a medium-sized computer have been developed for each of the two refineries of Tidewater Co. A basic IBM 650 all-purpose computer with magnetic drum type memory capacity of 2000 ten-digit decimal numbers was used.

A number of premises must be fixed and include vol of charge material and point of entry, sales requirements of products, equipment capacity limitations, finished product specifications, and economic variables, including cost of raw materials.

The simulation programme can be used to evaluate individual crude oils or mixes, short- and long-range planning of operations, projecting economic benefits of investments in new refinery process units, and optimization studies of company-wide operations. G. A. C.

1587. Liquid–liquid extraction. Efficiency of a pulsating perforated plate column. B. Choffé and Y. L. Gladel. *Rev. Inst. franç. Pétrole*, 1959, **14**, 108–15.—Column used is described and shown diagrammatically. Extraction of benzoic acid from toluene by water was studied, importance of using pure materials being stressed. Effects on efficiency of separation of total flow rate, relative flow rates of the two

phases, and frequency and amplitude of the pulsations are shown graphically. Pulsation can increase efficiency of the column by a factor >3. Eight refs. W. A. M.

1588. New standard in pollution control set by Canadian refinery. J. D. Frame. *Internat. Oilman*, 1959, **13**, 224–5.—The combined effluent of Cities Services Oil Co. Ltd's Trafalgar refinery in Bronte, Ontario, averaging 300 gal/min, is bulked and oil and solids are separated with the help of $Fe_2(SO_4)_3$. Most of the noxious content, including phenols, is removed by aerobic bacterial sludge treatment and the remainder by treatment with O_3, activated C, and filtration. The final effluent is fit to drink. G. B.

1589. Air cooling in petrochemical plants. R. T. Matthews. *Oil Gas J.*, 22.6.59, **57** (26), 128.—Unusual problems which are met with are discussed when applying air cooling units to chemical plants. Operating costs to be considered include maintenance and cleaning of exchangers, power costs for air-cooler fans, water supply, treatment and disposal costs. Approx ratio is 4 to 1 for cleaning, and maintenance costs for water as against air-cooled exchangers, outlet process and design air temp, and log mean temp will have influence on size of air-cooled exchanger. Best economic advantage is when air-cooled equipment is located close to the process unit. Problems involved with air cooling include atmospheric corrosion, fire and toxic-fumes hazard, maintenance and cleaning of units working above 150 psi, and control of noise from propeller fans.

A table gives application grade for air-cooled heat exchangers. G. A. C.

DISTILLATION

1590. Predicting vapour–liquid equilibrium relationships in multi-component systems. W. E. Ehrett, J. H. Weber, and D. S. Hoffman. *Industr. Engng Chem.*, 1959, **51**, 711.—One method of predicting the y/x ratio of a component in a vapour–liq mixture at equilibrium conditions is through use of the ideal K. As the volumetric data required for accurate calculation are lacking, generalized methods were developed for the prediction of ideal K data.

A generalized chart for estimating standard-state liq fugacities of pure components is presented. This and previously developed f/P charts permit estimation of ideal K's. The two generalized fugacity charts are combined in a single generalized plot for estimation of ideal K's. K values estimated from the graphical correlations presented in this work and from previous methods, compared with literature data, demonstrate the advantages of the new correlations. M. F. M.

1591. Computer control of internal reflux in fractionators. D. E. Lupfer and D. E. Berger. *Oil Gas J.*, 3.8.59, **57** (32), 68.—Aerial cooling brings some problems, including changing ambient conditions such as may be caused by a sudden rainstorm, which can upset fractionator operation due to changes in the internal reflux rate.

The use of a simple pneumatic analogue computer helps solve the problem. Interacting control loops must be isolated and disturbances regulated before their entry into the equipment.

The article discusses effects of reflux temp changes and shows that the system is regenerative, the immediate effect being a change in internal reflux rate which can be kept constant by manipulating the external reflux rate.

Care must be taken to properly apply the computer control system to any particular fractionator; location of the external reflux temp measurement is critical if full benefit is to be obtained. The reflux temp should not be measured within the reflux accumulator, nor in the reflux line at a long distance from entry into column. G. A. C.

CRACKING

1592. Two-stage cat cracking proves out. Anon. *Chem. Engng*, 1.6.59, **66** (11), 46.—Engineering evaluation of Shell Oil's two-stage cat cracker at its Anacortes (Washington) refinery has uncovered some valuable technical and economic observations which are described briefly in this short paper. The major conclusions are: (1) Two-stage route becomes more profitable as gasoline to dist production ratio increases and cat crackers are forced to operate at higher severity and conversion. (2) Two-stage design helps to retain valuable olefins in light gas stream and gasoline fractions, reduces slightly the amount of aromatics in effluent from cracking operation.

Shell's unit consists of a riser (dilute phase), reactor, a dense-bed reactor, two fractionators, a cat stripper, and a regenerator. The riser reactor is sized for an intake of 23,600 bpd and gives 40–50% conversion. The dense bed reactor is designed for a gas oil charge from the first stage, with a throughput rate of 13,000–30,000 bpd and 65–90% conversion. A process flowsheet is included in the paper, and various plant items are briefly described. M. F. M.

1593. Evaluating cracking characteristics of fluidized fixed beds and continuous catalytic cracking units. J. A. Andrews. *Industr. Engng Chem.*, 1959, **51**, 507.—There are substantial differences in the cat cracking characteristics exhibited by various types of cat cracking units.

These differences between various types of units are clarified and a mathematical procedure is offered for evaluating the relative cracking characteristics of fluid fixed bed; continuous, perfectly mixed reactors; continuous, transfer line (piston displacement) reactors; and dual reactors which have a transfer line preceding a perfectly mixed bed.

Detailed experimental lab work has confirmed the mathematical comparison of fixed bed and perfectly mixed reactors, and preliminary evaluations of commercial transfer line reactors have verified the mathematical analysis, which shows a substantial reduction in carbon yields for the transfer line reactor. M. F. M.

1594. Silica–alumina petroleum cracking catalyst. W. H. Shearon, Jr and W. R. Fullem. *Industr. Engng Chem.*, 1959, **51**, 720.—Significant technical advances have led to development of cat cracking which has produced by-products such as plastics and synthetic rubbers, and founded new industrial complex, the petrochemical industry.

W. R. Grace & Co, Davison Chemical Division, has a number of synthetic fluid cracking plants; the one at Lake Charles, Louisiana, is described. Davison produces petroleum reforming and speciality cat, sulphuric acid, sodium silicate, and a variety of other products for chemical and fertilizer industry.

Davison used a continuous process for producing silica–alumina gel slurry. All raw materials are closely controlled by flow rates and recording rotameters. Final spray dried cat is composed of microspheroids of 20–80 μ in dia. M. F. M.

1595. Socony's new spherical reactor. Anon. *Oil Gas J.*, 17.8.59, **57** (34), 219.—A new cat reforming reactor of unusual design is described. Features include stainless steel liner supported within reactor at bottom on a flat plate resting on concrete reactor of spherical shape and reduced thickness, and gunned concrete insulation to provide a shell surface temp of 950° F. A diagram of reactor is given. G. A. C.

1596. Recovery of pure aromatics in France. V. E. Henny, H. W. Grote, and F. A. Trim. *Bull. Ass. franç. Tech. Pétrole*, 1959, 359–82.—French consumption and use of BTX are tabulated. If all 60/135° C (Iraq) cut available in France were cat reformed, yield of BTX (000's tons) would be 48/250/300, giving insufficient B and also posing resultant

motor fuel quality problem. Other indigenous sources (coke oven gas, Lacq gas, steam cracking) are surveyed. Aromatic separation processes are considered, with special reference to cost and operation of Udex. Conclusion is that T/X is in ample supply but B is short and import will be required.
V. B.

POLYMERIZATION

1597. Copolymerization of ethylene with aliphatic α-olefins. VI. Copolymerization of ethylene with butene-1. (In Italian.) C. Natta *et al. Chim. e Industr.*, 1959, **41**, 764–75.—Using cat prepared from vanadium halides and trialkylaluminium, it was possible to prepare, under proper experimental conditions, linear copolymers of ethylene with butene-1 having a high mol wt, which are free from homopolymers and prove to be amorphous by X-ray examination. The influence of the conditions adopted in the copolymerization and in the preparation of the cat on the composition of the copolymers is described. The reactivity ratios of ethylene and butene-1 are here determined. These ratios are compared with the ratios found for ethylene–propylene copolymerization using the same cat. (Authors' abstract.)

CHEMICAL AND PHYSICAL REFINING

1598. The Alkazid process for removing H_2S and CO_2 from gas. R. Leuhddemann *et al. Oil Gas J.*, 3.8.59, **57** (32), 100.—Originally the process was used to remove H_2S and CO_2 from natural and synthetic gases and was later developed for the purification of gases and extraction of H_2S from liq hydrocarbons in over 50 plants.

Concentrated aq soln of amino acids are used in an absorber, the process being a continuous recycle which can be carried out both at normal and elevated pressures. The spent soln is regenerated by heating and returned to the absorber via a heat exchanger.

The corrosion problem was overcome by using comparatively cheap aluminium for the more expensive stainless steel in reboiler, heat exchanger, etc. Charts show partial pressure of H_2S and CO_2 over Alkazid soln and absorption of the gases by the soln. A table gives selectivity of Alkazid soln. G. A. C.

1599. Dehydrate with calcium chloride. E. R. Moore and W. G. Cutler. *Oil Gas J.*, 27.7.59, **57** (31), 167.—Pacific Northwest Pipeline Corpn have used wellhead dehydration units to process in excess of 100 billion cu ft natural gas to remove water in liq and vapour form before entering gathering system because of freezing conditions in the Rocky Mountains.

The dehydration unit contains a dessicant bed and uses brine in a series of trays; the wet gas from well enters at base of unit where free liq, water, and hydrocarbons are extracted before passing upwards to tray section. A large part of the water is removed as the gas passes through the brine, after which it flows through the calcium chloride bed, where the remaining water is absorbed by the pellets, and thence to the gathering system after metering.

Recharging is necessary after 75% depletion of calcium chloride, and frequency depends on flow pressure, temp, and vol; it varies from 3 weeks to 6 months.

Channelling and bridging is corrected by pouring water around vessel walls and dropping the calcium chloride to bottom of bed before recharging.

Operating costs for dehydration are $3 per MMcf of gas.
G. A. C.

1600. Bench scale continuous processing under high pressure. P. M. Beneken Kolmer. *Ingenieur, 's Grav.*, 28.8.59, **71** (35), Ch 43.—A bench scale unit for continuous high pressure processing is fully described. The particular problems connected with small scale reactors, the injection and metering of small gas flows at high pressures, and the general operational procedures are considered in detail. Typical operating pressures and temp are 50 atm and 400° C.

Examples of the temp gradients in the heater and the reactor units are given for the isomerization of *cyclo*hexane in the presence of cat cracking cat containing 5% nickel, and for the isomerization and dehydrogenation of *cyclo*hexane in the presence of 0·1% Pt and 2·1% Cl on Al_2O_3. D. C. E. deW.

SPECIAL PROCESSES

1601. Vinyl chloride production from petroleum hydrocarbons. (In German.) K. J. Kosterhon. *Erdöl u. Kohle*, 1958, **11**, 312–17, 390–3. Pt I. Vinyl chloride production over acetylene. Pt II. Production over ethylene.—Pt I describes vinylchloride production by HCl addn to C_2H_2 in one step by passing the gases through a tube furnace containing $HgCl_2$ on activated C—at 140°–200° C according to the cat age. C_2H_2 is prepared by the CaC_2-to-H_2O or the H_2O-to-CaC_2 process, partial combustion of hydrocarbons, electrical cracking of CH_4 of >90% purity or other low-mol hydrocarbons in an electric arc, or by thermal cracking of hydrocarbons. Operational details are discussed. 27 refs. Pt II describes vinylchloride production over C_2H_4. In the first stage Cl_2 reacts with C_2H_4 to form dichloroethane; vinylchloride is produced by splitting HCl from $C_2H_4Cl_2$. The reaction is simple to carry out and is more economical than the production over C_2H_2. Heat removal is essential. Cracking can proceed thermally in the gas phase or in the alk–liq phase. A flow scheme of vinylchloride production over pure C_2H_4—prepared as described—and the dichloroethane pyrolysis is presented. 16 refs.
R. T.

1602. Catalytic dehydrocyclization of hydrocarbons in the presence of sulphur dioxide. R. C. Odioso, D. H. Parker, and R. C. Zabor. *Industr. Engng Chem.*, 1959, **51**, 921.—Conflicting reports appear concerning the nature of the products obtained from the dehydrocyclization of paraffins and olefins having at least a six-carbon linear chain over chromia–alumina cat in the presence of sulphur dioxide.

Re-investigation has shown that aromatic hydrocarbons and thiophenes are formed simultaneously at the reported conditions with these feeds. However, with a *cyclo*paraffin, such as *cyclo*hexane, sulphur dioxide, and an activated carbon cat, the only product is benzene, with virtually no formation of thiophenes.

There seems to be no practical advantage in the use of sulphur dioxide to dehydrocyclize straight-chain paraffins and olefins. The desired aromatic cpds are contaminated with thiophenes, and the efficiencies of conversion to aromatics are considerably lower than when hydrogen is used. M. F. M.

1603. Urea for oil dewaxing. C. S. Cronan. *Chem. Engng*, 18.5.59, **66** (10), 142.—Sonneborn's Petrolia refinery has successfully used urea for medicinal white oil dewaxing in a two-stage batch process. Pour point is lowered from 25° to 0° F and the cloud point from 40° to 6°–8° F after urea dewaxing operation. The equipment in the dewaxing operation consists simply of two 5000-gal stirred tanks, a pump, and a rotary vacuum filter, and the one operator on the unit comprises two-thirds of the total operating cost. Total time cycle for dewaxing a batch of oil and then regenerating urea is *ca* 7 hr. Around 2500 gal of raw oil, along with 4300 lb of urea, are charged to the dewaxing tank in a single batch. The paper includes the process flowsheet and some pictures of the plant. M. F. M.

1604. Natural gas processing plant. C. S. Cronan. *Chem. Engng*, 20.4.59, **66** (8), 148.—In the Alberta foothills of the

Canadian Rockies, British-American Oil Co has completed its Pincher Creek plant for processing natural gas from the nearby wells. The H_2S content of the natural gas in this region is very high (*ca* 11%). Its recovery from the gas stream is affected by monoethanol–amine process. H_2S is then oxidized and converted to elemental sulphur. Based on a throughput of 142 MMcf gas/day, the plant can recover daily 100 MMcf residue gas, 4200 brl of stabilized condensate, 20,000 gal of propane, 30,000 gal of butane, and 500 tons of sulphur.

The paper gives a full process flowsheet. M. F. M.

1605. Cat reforming: road to high octanes. C. S. Cronan. *Chem. Engng*, 1.6.59, **66** (11), 90–5.—Cat reforming capacity has nearly doubled in the U.S.A. over the past three years. This is because of ever increasing demands on high-octane gasolines. Esso's Powerforming is one of the latest cat reforming processes to be used and is employed at Esso Standard's Bayway (N.J.) refinery. The process involves hydrogen treating of a low octane naphtha via a hydrofining process to remove the sulphur, then reforming this stock by dehydrogenation and dehydroisomerization of naphthenes with dehydrocyclization of paraffins. Minor reactions are paraffin isomerization and hydrocracking. For a 20,000-bd plant the requirements are 4000 lb/hr of steam, 5000 kW of power, 7400 gal/min of cooling water, and 300 million Btu/hr of direct fuel.

The process flowsheet and many interesting pictures of the plant are included in the paper. M. F. M.

PRODUCTS

CHEMISTRY AND PHYSICS

1606. Method for calculating boiling points by vacuum distillations. (In German.) H. Reckhard. *Erdöl u. Kohle*, 1958, **11**, 234–41.—A simple method for graphic and arithmetical determination of bp at pressures deviating from 760 mm. Detailed mathematical derivations lead to equations from which a universally applicable nomogram is developed. A magnitude *b* can be calc for each cpd which is a measure for the anomalous boiling behaviour of this cpd. Magnitude *b* was calc for 400 org substances. By a systematic group distribution of these cpds it is shown that for each group an approx equal val of const *b* can be indicated. This group val is discussed, and finally for each calculation operation a typical example is given. The method presented is suitable also for cpds, *e.g.* tars, tar oils, and other coal dist products. R. T.

1607. Iron ore reduction with petroleum products. (In German.) L. Weber. *Erdöl u. Kohle*, 1958, **11**, 241–4.—Efforts to meet the increasing demand for the scarce blast furnace coke are met by introducing the use of petroleum and its derivatives for iron ore reduction. Cast iron produced in the blast furnace is replaced by spongy iron for steel production. This material has been used successfully in the U.S.A. as high-grade scrap for producing high-grade steels. From a metallurgical viewpoint its freedom from undesirable impurities often renders it superior to cast iron. In view of world scarcity of blast furnace coke and increase in iron and steel production large quantities of petroleum products would be used as heating source and reducing medium. In contrast to blast furnace coke production the operation can be carried out economically in small operating units. Particular requirements of isolated steel works and rolling mills, and those of the lands beginning their own iron and steel production, can be met. Possibilities exist also for operating the process at the ore mines, thus reducing transport costs. R. T.

1608. The molecular structure of heavy petroleum compounds. A. Hood, R. J. Clerc, and M. J. O'Neal. *J. Inst. Petrol.*, 1959, **45**, 168–73.—The mass spectrometric picture of structure of high-boiling petroleum mol presented not only provides additional information on composition, but also suggests that the structural composition is much simpler than has been anticipated. According to this picture, the mol consist of one long carbon-atom chain, at one or possibly both ends of which a ring system or short branch may be attached. Evidence is presented that for multi-ring structures of from one- to four-ring mol the ring system is a condensed one. A. D. S.

1609. Chemistry of *cyclo*pentadiene. M. Prillieux. *Rev. Inst. franç. Pétrole*, 1959, **14**, 93–107.—*cyclo*Pentadiene (I) and methyl*cyclo*pentadiene are found in gasoline produced by thermal cracking under low pressure and can be extracted by dimerization by heating at 100° C for several hr, fractionation and removal of the dimers at the column bottom, and cracking at >200° C to re-form the monomers, which are finally separated by fractional dist. The dimer of (I) is much easier to handle and store industrially than the monomer; lab methods of preparing (I) from its dimer are given. Physical properties of (I) and its dimer are tabulated, and a detailed account of the chem properties and reactions of (I) is given, followed by a brief account of the chem properties of the dimer. Industrial uses of derivatives of (I) are summarized (*cf.* Abs **1435**, 1959). W. A. M.

1610. Use of magnetic methods in chemisorption and in heterogeneous catalysis. P. W. Selwood. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1649–65.—In chemisorption and heterogeneous catalysis by Ni the number of unpaired electrons is reduced, thus reducing the paramagnetism. The effect can be studied only with particles of <100 Å dia; this, however, is the approx size of the particles of Ni in commercial cat. Theoretical basis is outlined and two methods of following magnetic changes described. Application of the method to adsorption on Ni of H, He, A, Kr, N, NO, O, CO, CO_2, C_2H_4, C_3H_6, C_6H_6, and C_6H_{12} is described. Reaction mechanisms for hydrogenation of C_2H_4 and C_6H_6 are given. The method should be capable of application to Co, Fe, Fe oxides, and other paramagnetic oxides, provided the cat particles fall within the necessary size limitations. 20 refs. W. A. M.

1611. Propagation of flames in a closed tube. G. Dalmai. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1683–724.—A tentative explanation of the two-lobed shape of the inflammability ranges of a number of hydrocarbons is given in terms of the following sets of phenomena: (1) The apex lying between the two lobes is conditioned by flame quenching mainly caused by vibrations of the flame propagating inside a closed tube; (2) The " second region " of the inflammability range is due to preferential diffusion of the deficient component of greater diffusivity. This causes a shifting of the mixture composition and leads to the propagation of small axial flames. The mixtures are considered " at the limit," at the concn determining the passage from one lobe to the other. 69 refs. (Author's abstract.)

1612. Irradiation of petroleum hydrocarbons. Effects of particle types. Anon. *Industr. Engng Chem.*, 1959, **51**, 547.—Preceding work by the authors has shown the radiolysis of paraffins to yield mainly olefin and dimer. Current effort involves the effect of particle types on the hydrocarbons *cyclo*hexane, methyl*cyclo*hexane, heptane, and 2,4-dimethylpentane. These cpds were chosen to study the response of methyl groups to radiation.

The G-value ratios of olefinic to dimeric products suggest

that olefin formation occurs primarily in the ionization track, whereas dimer formation occurs mainly in the bulk of the liq.

The incorporation of cat amounts of an oil-soluble boron cpd in the atomic reactor experiments was found to increase the rate of product formation many-fold. M. F. M.

1613. Elastic and inelastic behaviour of some isotactic polymers. (In Italian.) G. Natta, M. Baccaredda, and E. Butta. *Chim e Industr.*, 1959, **41**, 737–40.—The dynamic mechanical properties of linear polymers of α-olefins (polypropylene, polybutylene, polystyrene) containing crystalline fractions having different steric purity have been determined. The transitions determined by means of the positions of the curve singular points of the sound velocity and of the damping factor as a function of the temp have values depending on the content of amorphous polymer and on the steric purity of the crystalline polymer. Fairly high values of the damping factor in wide temp ranges are observed examining only products having a high content of non-crystalline fractions.

(Authors' abstract.)

1614. Volumetric and dilatometric properties of some olefin polymers. (In Italian.) F. Danusso *et al. Chim. e Industr.*, 1959, **41**, 748–57.—Specific vol of samples of polyethylene with a high degree of linearity, and of polypropylene, polybutylene, and polystyrene with atactic, isotactic, and isotactic stereoblock structures were determined in wide temp ranges. Experimental data show typical influences of the macromolecular structure on the volumetric and dilatometric properties and on the behaviour of the examined polymers related to phase and *iso*phase transitions. The dilatometric straight lines which can be ascribed to the pure crystalline phase for each polymetric system were calculated. Thus, besides experimental data, which can be directly deduced, other values of thermodynamic interest, which are also useful to technical calculations, have been obtained. A method is also given, following which the degree of crystallinity of samples of the polymers studied can be determined by one measure of specific vol. (Authors' abstract.)

1615. Cross-linking density and physical properties of elastomers obtained by ethylene–propylene copolymers. (In Italian.) G. Crespi and M. Bruzzone. *Chim. e Industr.*, 1959, **41**, 741–8.—The simple extension behaviour of the ethylene–propylene copolymer cross-linked with dicumylperoxide and swollen in benzene agrees with the predictions of the kinetic theory. This allows the calculation of the cross-linking density and the yield with regards to the employed cross-linking agent. It is also shown that at high concn of the cross-linking agent the yield of the cross-linking reaction decreases. The equilibrium swelling data in benzene agree perfectly, according to the Flory–Huggins theoretic equation, with their cross-linking densities. The interaction constant between the ethylene–propylene copolymer and benzene has been determined, as well as the effect of the cross-linking density on the simple extension and on the rebound temp curve of the ethylene–propylene copolymer. (Authors' abstract.)

ANALYSIS AND TESTING

1616. Trace analysis for total nitrogen in petroleum fractions. Adsorption—ter Meulen method. E. C. Schluter, Jr. *Analyt. Chem.*, 1959, **31**, 1576–81.—Organic nitrogen in petroleum fractions can be determined in concn down to 0·1 ppm. The N cpds are adsorbed on a silica gel column, desorbed by H and heat, and passed over the ter Meulen cat. The NH_3 which is produced is determined by Nessler's method. The modified apparatus and procedure are described. G. B.

1617. Infra-red analysis of polybutadienes obtained by stereospecific synthesis. (In Italian.) D. Morero *et al. Chim. e Industr.*, 1959, **41**, 958–62.—The possibility of obtaining, by means of stereospecific synthesis, polybutadienes containing a very high percentage of 1,4 *trans*, 1,4 *cis*, or 1,2 units, allowed for the development of an ir method for the determination of the different types of insaturation in polybutadienes of any composition. In this method the bands at 10·34, 10·96 ÷ 10·98, 13·50 ÷ 13·65 μ arising from out-of-plane deformation of the =C–H bonds in the 1,4 *trans*, 1,2 and 1,4 *cis* units respectively are employed for analytical purposes.

(Authors' abstract.)

1618. New method of hydrocarbon structural group analysis. D. S. Montgomery and M. L. Boyd. *Analyt. Chem.*, 1959, **31**, 1290–8.—The method described is applicable to pure cpds. It requires the determination of the molar vol and molar refraction, C, aromatic C and H. Five equations have been developed which involve these quantities and must be solved simultaneously. This can be done with a computer. The method is not applicable to polycyclic non-fused structures, spiro cpds, three-dimensional ring systems, or to cpds containing olefinic or acetylenic bonds. The accuracy is discussed with reference to 114 cpds previously studied in the API Project 42. The results are tabulated. G. B.

1619. Four-ball test on lubricating oils containing solid particles. F. Hirano and S. Yamamoto. *Wear*, 1959, **2**, 349–63.—The variables investigated were the effects of hardness and concn of the particles, visc of the oil, and the rubbing speed. Soft particles, such as metals, collect in front of the contact area and interfere with the formation of the oil film. Hard particles penetrate to the contact area and cause abrasion. An empirical expression was established to define the relation between the concn of the particles and the area of abrasion. No such relation was found with the weight lost by abrasion. Solid lubricants did not penetrate to the contact area unless used in a sufficient concn to form a paste. G. B.

1620. Simple experimental process for determining periodic error of liquid meters. (In German.) H. Bluschke and J. Eberle. *Erdöl u. Kohle*, 1958, **11**, 322–6.—Errors and their origin inherent in conventional quantity meters are discussed. A new procedure on a kinematographic basis gives in one measuring operation the whole operational course of the periodic deviations. The liq flowing through the meter is led into a calibrated measuring tube and the measuring process is registered by simultaneous photographs on a film strip of the reading of the indicator fixed to the meter and of the measuring tube. The number of measuring points can be varied within wide limits by varying throughflow strength and by adjusting several film speeds on the camera. By this procedure—superior to the old experimental methods—a very close sequence of measuring points can be attained. Eight refs.

R. T.

1621. Rapid determination of phosphorus in motor oils and additives. J. E. Barney, J. G. Bergmann, and W. G. Tuskan. *Analyt. Chem.*, 1959, **31**, 1394–6.—A method is described by which P can be determined in one hr with a precision equal to that of the ASTM method D1091–54T. The sample is burned with O in a closed flask, the gases are absorbed in dil HNO_3, and P is determined as the phosphomolybdivanado complex either colorimetrically, as in the ASTM method, or by differential spectrophotometry. G. B.

1622. Rapid tests for oils in service. A. Schilling and J. Marlot. *Bull. Ass. franç. Tech. Pétrole*, 1959, 407–22.—First part (AS) covers motor oils. Description given of two commercial oil testing kits (Gerin, Simplex) followed by consideration in some detail (photos) of IFP spot test procedure (cf Abs **760**, 1959); resulting discussion reported. Second part (JM) covers turbine and transformer oils. Tests normally done on such used oils are excessive and could be restricted to colour and acidity, with perhaps sap val added in case of

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turbine oil. For both grades there is close correlation between acidity and colour. For used transformer oil Electricité de France set limit of: acidity × 15 + colour (NPA) ⩾10. V. B.

1623. Measuring the wear of internal combustion engines by means of emission spectroscopy. (In German.) E. Pietschmann. *Wear*, 1959, **2**, 335–48.—The various methods available for the estimation of wear in IC engines by the emission spectrum analysis of the wear particles contained in the oil are evaluated and compared with other known methods, in particular the radioactive component method, on the basis of the published literature and an experimental study. The analysis can be carried out on the ash, by four different procedures, or on the used oil without ashing, by the use of rotating carbon electrodes. As an example, the simultaneous determination of the wear of four components of a car engine is described. These methods are suitable for determination of the rate of wear. The limit of detection is $5{\cdot}1 \times 10^{-6}$% of an element in oil. The accuracy is within 10% relative by a direct procedure and 2% by an indirect method. 36 refs. The best conditions for each procedure were established. G. B.

1624. High mass spectrometry. Propylene polymer, alkylated benzene, and wax analysis. R. A. Brown *et al.* *Analyt. Chem.*, 1959, **31**, 1531–8.—Improvements made in the last decade in the construction and use of mass spectrometers with heated inlet systems are reviewed. The instruments permit the determination of ions over the mass range of 2–600 and yield spectra of hydrocarbons with up to 50 C atoms. Quantitative methods of analysis are presented for propylene polymers, alkylated benzenes, and petroleum waxes with calibration data to enable these methods to be used in other laboratories. The methods of calculation are designed for a digital computer. G. B.

1625. Determination of manganese in gasoline by X-ray emission spectrography. R. A. Jones. *Analyt. Chem.*, 1959, **31**, 1341–4.—Manganese in gasoline, in which it may be present as the anti-knock additive methyl*cyclo*pentadienyl manganese tricarbonyl, in concn of 0·1–1·0 g of Mn/gal, can be determined in 15 minutes with a standard deviation of 0·007 g/gal. A single calibration curve applies to all samples normally encountered. An iron rod immersed in the specimen serves as a reference to compensate for interferences caused by other additives. G. B.

1626. Gas–liquid partition chromatography of sulphur compounds with ββ′-iminodipropionitrile. J. H. Karchner. *Analyt. Chem.*, 1959, **31**, 1377–9.—By GLPC on a stationary phase of ββ′-iminodipropionitrile cpds are separated according to their electrophilic character. The retention times of 11 S cpds which occur in crude oil were determined on this stationary phase and the log plotted against the log of the retention times on a stationary phase (white oil) which separates the cpds according to their volatility. A series of parallel straight lines was obtained, each representing a class of S cpd. The cpds examined all boiled between 58° and 126° C. G. B.

1627. Gas chromatographic analyser and recorder. M. Vélut and J. Jourda. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1635–47.—A general account of GLC and of Scott's and Janak's apparatus is followed by a more detailed account of the conversion to automatic operation of a Janak-type apparatus. The eluant gas causes an increased pressure which is transmitted to a micromanometer, movement of which actuates a relay which operates a compensating reservoir. The movement of the reservoir is transmitted to a recorder. The apparatus has been used for rapid analysis of hydrocarbon mixtures up to C_4. W. A. M.

1628. Testing tube as detector in gas chromatography. (In German.) K. Grosskop. *Erdöl u. Kohle*, 1958, **11**, 304–6.—The working principle of the simple gas trace instruments with which the testing tubes are used is sketched briefly. The analytical technique is referred to the obvious analogies to chromatography and colorimetry. Originally designed for industrial gas analysis the tubes—by the analysis of C_3H_8–C_4H_{10}—are shown to be suitable for detectors in gas chromatography. R. T.

1629. Gas–liquid partition chromatography of isomeric alkyl*cyclo*pentenes and alkylene*cyclo*pentanes. J. Shabtai, J. Herling, and E. Gil-Av. *J. Chromatog.*, 1959, **2**, 406–10.—These cpds, which are of interest for their occurrence in cat cracked gasolines, can be completely separated and determined by GLPC on a stationary phase of glycol saturated with $AgNO_3$. Retention vol relative to toluene are listed. G. B.

CRUDE OIL

1630. Study of crude oil desalting. C. Labbé. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1622–34.—Some crudes contain salt crystals, and they may also have some emulsified water which is not saturated with salt. Desalting has been investigated in the lab, water being added together with a surface-active agent. Anionic surface-active agents gave interesting results. Two soluble in water (alkylaryl sulphonic acid and alkyl sulphates) were investigated in detail. A demulsifying agent was also investigated.

Desalting seems to depend on wetting and on demulsification, and the experiments support this. In diminishing order of efficiency the sequence is alkylaryl sulphonic acid (1), the demulsifying agent (2), alkyl sulphates (3). Tests showed the order in wetting power to be (1), (3), (2) and in demulsifying power (2), (1), (3). G. D. H.

GAS

1631. Lacq factory. — Jean-Pierre. *Bull. Ass. franç. Tech., Pétrole*, 1959, 721–38.—Deep (3550 m) Lacq deposit discovered 1951. Gas at 125° C, 700 kg/m³, (%) CH_4 69·1, H_2S 15·3, CO_2 9·7, C_2+ 5·1, H_2O 0·7, RSH 0·05, COS 0·05. 75% of H_2O sep at well-head before gas transfer (glycol (recoverable) injection to prevent hydrate formation in lines) to treating plant. Separators remove condensed hydrocarbons and glycol-containing water. Safety measures (toxicity and explosion risks) are described. H_2S/CO_2 is eliminated by H_2O wash at 25 kg/cm² (½ removed) followed by amine treatment. Gas is dried, then freed from C_{3+} by low temp (−70° C) fract. S is made by cat (bauxite) conversion (*ca* 225° C) of SO_2 (from combustion of part of H_2S in steam plant) + H_2S. S yield is 96/7%, $C_3 + C_4$ is NaOH washed. CHG is refined by clay treatment at 380° C, followed by NaOH and H_2O. Flow sheets of various process stages. Yields (per million m³, investment 3×10^9 fr): dry gas for delivery 600,000 m³, S 200 tons, $C_3 + C_4$ 20 tons, gasoline 35 tons. By end of 1960 annual schedule is $4{\cdot}2 \times 10^9$ m³ delivered gas, 1·4 m tons S, 140,000 tons $C_3 + C_4$, 245,000 tons gasoline. Derived chem, C_2H_4 25,000 tons pa, CH_3SH 500 tons pa, pure H_2S 700 tons pa. V. B.

1632. Natural gas. France may soon overtake Italy. Anon. *Times Rev. Ind.*, 1959, **18** (151), 116–17 (*cf* preceding abs.).—Reserves 2×10^{11} m³. Pipeline distribution system (covering 30 depts) is outlined. V. B.

ENGINE FUELS

1633. Cavitation and NPSH requirements of various liquids. V. Salemann. *Trans. Amer. Soc. mech. Engrs*, 1959, **81D**, 167–73.—Net positive suction head, NPSH, is defined as

difference between abs suction head and vapour pressure at suction temp. Test results on NPSH requirements for centrifugal pumps handling water up to 420° F, some hydrocarbons, including benzene, butane, butane–propane mixtures, gasoline and kerosine, and Freon-11, are presented. Satisfactory pump performance was observed with net positive suction heads less than those required by the pump or cold water. A direct measurement of NPSH was attempted and is reported. The cavitation process is discussed, and a correlation and method of prediction for all liq is proposed. A. D. S.

1634. Use of suspensions in propulsion systems. M. Martin and B. Salé. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1666–82.—Literature review of theory, preparation, properties, and use in ramjets and reheat combustion chambers of suspensions of Al, Mg, B, and pentaborane in liq hydrocarbon fuels. 31 refs. W. A. M.

1635. Diester-base jet engine oils. F. L. James, C. M. Murphy, and J. G. O'Rear. *Industr. Engng Chem.*, 1959, **51**, 673.—The increasing corrosivity of diester-base jet-engine oils during storage has been attributed to half ester formation, necessitating a study of the reaction: diester + sebacic acid $\rightleftarrows$ 2 half ester.

This acidolysis reaction is completely reversible and insensitive to temp. Equilibrium constants are reported. Initial reaction rates and half equilibration times are given from 25° to 300° C.

Uncatalysed acidolysis reactions are too slow at storage temp to account for the formation of the corrosive half ester. An engine operating temp acidolysis reactions are sufficiently fast to influence oil composition. During storage, increases in corrosivity are accompanied by increases in acidity, as would result from hydrolysis but not acidolysis. M. F. M.

1636. Power fuel and motor. (In German.) H. Hoffmann. *Erdöl u. Kohle*, 1958, **11**, 169–73. **Pt 2. Power fuel and Otto motor.**—The many effects which changes in fuel quality can have on the working of Otto motors are mentioned. Knock resistance is a most important effect. Both ON of commercial gasoline and C.R. of modern motors rise ever higher. America has investigated basic questions for determining combustion chamber form—standard forms are illustrated—separated according to magnitudes: flame path, spark plug position, valve arrangement, air eddying, and pinch surface formation. Increasing C.R. is the simplest method for enhancing performance and thermal eff. A higher chem ON, namely, that of the fuel, also a higher mechanical ON, namely, of the motor, is required. Operation in a favourably designed combustion chamber is possible with a fuel of lower chem ON. In an unfavourably designed combustion chamber fuel with a correspondingly higher ON must be used to obtain the same attainable knock-free performance. Advantages and disadvantages of intermittent direct fuel injection are discussed. Further important factors discussed are medium pressure attained, dependent on motor construction, road fuel consumption, dependent on sp gr of fuel, and ON requirement, dependent on air–fuel ratio. R. T.

GAS OIL AND FUEL OIL

1637. Processing of low-grade iron ore using petroleum and natural gas. P. E. Cavanagh. *Engng J., Montreal*, Aug 1959, **42** (8), 84–7.—Processes for working-up low-grade ore without the use of metallurgical coke are briefly surveyed and compared. Magnetic ore can be concentrated magnetically. Haematite can be converted into magnetic oxide by roasting. The concentrate can be sintered or formed into pellets by heat and pressure. Sponge iron from direct reduction processes in which the ore is heated and brought into contact with reducing gas is best melted to yield high purity pig iron. Costs of the various processes are compared on this basis. Oil or natural gas can be used as fuel in all these processes. G. B.

1638. Additives for boiler fuel oil, symposium. *Bull. Ass. franç. Tech. Pétrole*, 1959, 625–43.—Experience of (U.K.) CEGB summarized (Jarvis), trials made with dolomite, $MgCO_3$, C + Zn, NH_3, coal tar bases, CO injection. CEGB has standardized on 1% free O_2 in stack gases (15% CO_2), Zn powder addition (0·05%) to fuel, daily check of solids in stack gases. EdF (Vigneron) carried out tests with dolomite and NH_3, corrosion costs of 100 fr/ton fuel are tolerated. Ammonia injection scheme of BP is described (Guillermic), amount of NH_3 (kg/ton) $\leqslant$0·38% of fuel, cost *ca* 100 fr/ton. Combustion cat (Dumortier) if efficient lower flame luminosity temp (filament extinction at λ 6500 Å) by 20°–100° C and raise CO_2 by $\frac{1}{2}$–$1\frac{1}{2}$% without adjustment, flame gas temp is raised by 10°–20° C, fuel consumption is increased $3\frac{1}{2}$%. Effects and mechanism are discussed (cat nature and quant not stated). Use of "Teramins" (3ry coal tar amines) (Vignal) decreases corrosion by *ca* 80% at dosage of 0·06%, above which deposits increase. Use of 0·03% Mg naphthenate lowers dew pt by *ca* 10° to 117° C. Report of general discussion. V. B.

LUBRICANTS

1639. New experiences with roller bearing lubricants. (In German.) H. Diergarten and J. Stöcker. *Erdöl u. Kohle*, 1958, **11**, 306–11.—Exchange of knowledge and collaboration between grease producers and consumers in recent years—especially in using mechanical–dynamic testing procedures—have led to remarkable improvements and advances in the sphere of roller bearing greases. Diversity and complexity of the questions relative to roller bearing lub greases are presented schematically. This scheme shows the life period of the grease on the basis of the bearing cage and grease type, temp, rev, and load with their appropriate formulation by accumulating new information. Since, according to DIN 51825E for special roller bearing greases, the development is not yet closed, still no definite properties can be fixed for low- and high-temp greases, high-pressure greases for especially high sp bearing loads, and greases for especially high rev. 17 refs. R. T.

1640. On the effect of lubricant inertia in the theory of hydrodynamic lubrication. A. A. Milne. *Trans. Amer. Soc. mech. Engrs*, 1959, **81D**, 239–44.—A theoretical study is made of the corrections required to the basic lubrication eqn to allow for small effects of lubricant inertia in the laminar region. The problem is approached by first determining the stream function for a wedge-shaped oil film with purely viscous flow and then obtaining the first-order correction for inertia. For the particular case where the convergency of the film is small, the resulting expressions for pressure gradient and tangential drag are compared with those obtained by other methods. Close agreement is found with Kahlert's eqn, but the present expressions are more general in form. It would appear that, in general, the effect of lubricant inertia is to cause a slight increase in load capacity of a bearing. (Author's abstract.)

1641. Status and development of molybdenum disulphide lubrication. O. L. Studer. *Schweiz. Arch. angew. Wiss.*, 1959, **25**, 201–10.—MoS_2 forms boundary layer without affecting metal surface; coeff friction falls with increasing load. Available MoS_2 lubricants can be classed in five groups: powders and pastes (properties of pure MoS_2 tabulated in detail); greases incorporating MoS_2, especially Li-based; MoS_2-containing liq, colloidal and semi-colloidal suspensions with up to 10% MoS_2, carrier can be oil (mineral or synthetic) or aq; lacquers (MoS_2 replacing pigment); special composi-

tions, such as cast resins. Main properties and typical uses of each group are discussed. V. B.

1642. Surface finish and clearance effects on journal-bearing load capacity and friction. F. W. Ocvirk and G. B. Dubois. *Trans. Amer. Soc. mech. Engrs*, 1959, **81D**, 245–52.—A method of relating surface finish to minimum oil-film thickness and the corresponding load capacity of plain journal bearings is presented with supporting experimental data. Curves of load capacity and friction are presented in a manner which aids in clarifying the effect of film thickness and clearance ratio on the performance of plain journal bearings. The criterion for determining the load capacity of a bearing in terms of surface roughness and Tarasov's factors appears to be well supported by the Burwell *et al* experimental data for the length–dia ratio of the bearing equal to one-half. A. D. S.

1643. Organometallics in lubrication. M. Antler. *Industr. Engng Chem.*, 1959, **51**, 753.—Organometallics are often effective in reducing the friction and wear of rubbing metals. A systematic study was made in bench equipment with representative cpds, including TEL (methyl*cyclo*pentadienyl), manganese tricarbonyl, and di-*n*-butyltin sulphide, alone or as additives in fluid lubricants, under many test conditions.

Worn surfaces were studied by electron diffraction and emission spectroscopy. Inorganic solids, produced on the surfaces by thermal degradation of the organometallic due to localized frictional heating, were detected and usually identified. Some solids, including recognized solid lubricants, were derived wholly from the additive, *i.e.* without chemical attack of the surfaces.

Our expanding technology requires new approaches to lubrication problems. Organometallics should be considered for their potential utility. It is likely that end-use applications can be developed. M. F. M.

1644. Halogenated gases for high temperature lubrication of metals. D. H. Buckley and R. L. Johnson. *Industr. Engng Chem.*, 1959, **51**, 699.—Lubricants are required for 1000° F and higher, where conventional organic liq and greases are no longer useful. The halogenated methane derivatives considered as lubricants can be stable at 1000° F and will lubricate by surface reaction but may corrode metals.

Several nickel and cobalt alloys resist corrosion at up to 1200° F. Postulated reaction products were known to be solid lubricants. CF_2Cl_2 plus 1% SF_6 lubricated 7·5% silicon–nickel sliding on Rexalloy 33 and was most effective for 600°–1200° F. With 98M2 Stellite on Hastelloy C, CF_3Br_2 was effective to 1200° F; however, chemical wear increased above 600° F, CF_3Br plus 1% SF_6 also lubricated to 1200° F, but gave minimum wear above 800° F.

Effective lubrication can be obtained with gases from 75° to 1200° F. The optimum combinations of materials and gases for good lubrication varied with temp. M. F. M.

BITUMEN, ASPHALT, AND TAR

1645. Better compaction control with nuclear test methods. H. A. Radzikowski and N. J. Cohen. *Rds & Str.*, July 1959, **102** (7), 129. The nuclear test instrument determines density and moisture content at greater speed and gives closer control over quality than the conventional procedures, without disturbing soil structure. The instrument with electronic counter costs *ca* $2200, and employs a radium–D beryllium radioactive source which produces a radiation of γ and neutron rays. These are partially absorbed and partially reflected; the latter pass through the counter tubes and are amplified, the counts per minute being read on a gauge. These counts are related to density and moisture by calibration curves. A table compares density and moisture results by conventional and nuclear methods. G. A. C.

1646. Pre-treatment of soils and clays for measuring external surface area by glycerol retention. E. B. Kinter and S. Diamond. *Publ. Rds, Wash.*, 1959, **30**, 187.—Plasticity and vol changes in properties of soil are caused by interaction of soil particle surfaces and water. Interactions between particle surfaces and chemical additives are concerned in soil stabilization. Both types of interaction are largely controlled by the amount of surface area possessed by the soil particles in a given soil.

Results of recent work concerning an improvement in the method developed by the U.S. Bureau of Public Roads in 1956 for measuring the surface area of soil materials for evaluating soil properties for highway purposes are reported. Tables show effect of pre-treatments on external surface area, and on internal and total surface areas calculated from glycerol retention. The data show that when soils are heated at 600° C the external surface area of several other minerals associated with montmorillonite is seriously affected and the complete collapse of montmorillonite is not necessarily obtained, thus the pre-treatment may introduce large errors in surface area measurements. Pre-treatment by saturation with triethylammonium cation prevents adsorption of glycerol on internal surfaces without interfering with external surfaces, and thus accurate measurements of surface areas can be made. G. A. C.

DERIVED CHEMICAL PRODUCTS

1647. Chemicals from petroleum. R. F. Fremed. *Chem. Engng*, 18.5.59, **66** (10), 151.—This article has been specially prepared in conjunction with the Fifth World Petroleum Congress to give the reader a general introduction to petrochemicals. Special "maps" guide the reader through key routes to each cpd, and a comprehensive survey indicates where to acquire the know-how for their manufacture and who offers these processes. Chemicals derived from petroleum, natural gas, and coal are dealt with. M. F. M.

1648. From petroleum to chemical products. C. E. Morrell. *Rev. Inst. franç. Pétrole*, 1959, **14**, 80–92.—General review of processes used for separation and transformation of petroleum hydrocarbons to useful chem products, including physical separation, thermal and cat cracking, dehydrogenation, polymerization, alkylation, and oxidn. Influence of rise of petrochem industry on development of new chem processes and on understanding of reaction kinetics and cat is shown. W. A. M.

1649. New process for obtaining the oxidation products of tetralin (α-tetralone, α-naphthol, tetralic acid). J. C. Lecoq. *Rev. Inst. franç. Pétrole*, 1958, **13**, 1725–38.—The IFP process for the production of α-tetralone from tetralin avoids build-up of hydroperoxides; oxidn is effected by O_2 in liq phase at 100° C at 0·5 atm in acetic acid with Co salt cat. Products are α-tetralone, α-naphthol, and tar. The IFP process for production of tetralic acid (carboxy-2-phenylpropionic acid) consists of oxidn of α-tetralone with HNO_3 in liq phase, cat being ammonium metavanadate and copper nitrate. Products are tetralic acid and phthalic anhydride, with some tar. For both processes apparatus is shown diagrammatically, and details of process and of separation of products are given. An economic assessment of each process is made. W. A. M.

1650. Ethylene oxide derivatives. Glycols and ethanolamines. D. G. Weaver and J. L. Smart. *Industr. Engng Chem.*, 1959, **51**, 894.—Canadian consumption of ethylene glycols (nearing 100,000,000 lb pa, mostly for automobile anti-freeze) is now satisfied mainly through production from Dow of Canada's Sarnia operation, which went on stream in 1948.

Starting with ethylene, water, and chlorine, Dow of Canada first makes chlorohydrin. This undergoes alkaline hydrolysis

to form ethylene oxide, which is itself hydrolysed further to give a mixture of ethylene glycols.

To produce ethanolamines (used chiefly in gas processing and detergent manufacture), Dow of Canada brought in a new unit in 1957. Here, ethylene oxide from the glycols plant reacts with ammonia in a conventional process.

For the first time, in this report, Dow of Canada has opened its doors to the technical press. M. F. M.

COAL, SHALE, AND PEAT

1651. Production of pipeline gas by hydrogenolysis of oil shale. E. B. Sheitz, Jr and H. R. Linden. *Industr. Engng Chem.*, 1959, **51**, 573.—Hydrogenolysis of oil shale to pipeline gas was investigated as an alternative method for utilizing large reserves of this fossil fuel. A 22·9-gal/ton Fischer assay Colorado oil shale was processed in a batch reactor at temp of 1200°–1300° F and pressures of 1100–5700 psig. Rapid conversion of 90–100% of the organic matter to 800 Btu/SCF fuel gas of high methane and ethane content was achieved in the presence of stoichiometric hydrogen requirements for methane formation, with only little formation of carbon oxides from mineral carbonate decomposition.

Low material costs point to the feasibility of supplementing the future supply of natural gas with high heating value gas from oil shale, particularly in areas served by long-distance transmission lines passing near the Colorado deposits. M. F. M.

1652. Sulphur in tar; bibliographic study. (In Spanish.) J. M. G. Rodriguez. *Combustibles (Zaragoza)*, 1958, **18**, 205–21.—Methods of separation and identification of sulphur cpds in coal tar: analysis; extraction (HF, SO_3, H_2SO_4); separation (physical: adsorption, thermal diffusion; chemical). Many of techniques discussed are derived from or applicable to treatment of petroleum dist. V. B.

CORROSION

1653. Corrosion behaviour of non-drying oils and fats with special reference to modern lubricants and metal protectives. A. Bukowiecki. *Schweiz. Arch. angew. Wiss.*, 1958, **24**, 201–17, 263–70, 295–303; 1959, **25**, 23–34, 62–74, 96–101, 126–43.—Non-drying oils and fats considered (natural glycerides with I. val <95), mineral oils (and additives therefor), coal tar products, synthetic oils. Corrosion problems associated with such oils and principal factors governing metal attack thereby; cat decomposition of oil by metal, leading to formation low mol wt acids, is important factor. Literature on metal attack by oils and fats is surveyed, including action of hot IC engine oils. Results are given of numerous tests carried out by the author on flat metal plates having a semicircular depression of 1 cm dia in which test oil is placed. Oils tested included mineral oils and such with a variety of additives. Results indicate that total acidity of oil is not related to its corrosivity (to Fe) but that significant part is played by acidic products of oxidative degradation of the oil. Resultant hygroscopic ferrous salts absorb moisture, leading to rusting. Copper strip test was investigated on a white oil containing ½% added S. Only Cu, Ag, and some Cu-containing alloys reacted, but brass with 60% Cu was unaffected. Duration of test is important, numerous SAE 90 gear oils which showed no change in Cu strip after 1 hr gave positive result after 3 days (tests at 122° C). Iron plates immersed in automobile gear oils (3 days, 120° C) subsequently cleaned and exposed (7 days) to damp (100%) air show rusting, caused by thin film of hygroscopic $FeCl_2$; this test procedure has been officially adopted in Switzerland as corrosivity test for automotive gear oils, limits set are wt change after immersion in oil ± 5 g/m² max, wt increase after subsequent 7 days in damp air 5 g/m² max. Cl-free oils can show slight rusting. Corrosion tests on regular and premium motor oils (SAE 30) on Pb, Cu, Fe, 140° C, 36 hr, showed clear distinction, in attack on Pb, between Premium and HD oils on one hand and Regular on the other; oil ratings can be reversed if test is carried out in closed instead of open vessel, confirming view of importance of volatile acids. Numerous graphs show effect of various additives and variations in test conditions. Corrosion test results are also given on big end bearings (8 Pb bronzes with varying types of protective layers). Test results given on corrosivity of water-containing (5%) oils, rust inhibiting effect of 0·1% stearic acid is marked on Fe, Cu, and Zn but not on Pb. Similar tests with diesel fuel showed no connexion between corrosivity and acid val of fuel for Fe, but a relation for Zn, Cd, and Pb. Corrosion protection of metals by thin oil and grease layers is considered in some detail, with numerous test results and photographs. 245 refs. V. B.

1654. Sulphide scaling under hydrofining conditions. 3. W. H. Sharp and E. W. Haycock. *Oil Gas J.*, 22.6.59, **57** (26), 102.—In this concluding article the prediction is discussed of long term corrosion rates, extrapolation errors being minimized, by using kinetic analysis. For example, data obtained during the investigation confirm that there is no effect of hydrogen pressure over a wide range (60–600 psia), thus plots of corrosion data against this pressure rather than against concn should be used. Extrapolation of plots show that at high H_2S partial pressures and temp corrosion rates of stainless steel will exceed those of low chromium steels. Tables show sulphide corrosion wt losses. G. A. C.

1655. Acetylene corrosion inhibitors. G. L. Foster, B. D. Oaks, and C. H. Kucera. *Industr. Engng Chem.*, 1959, **51**, 825.—As oil wells are drilled deeper, and higher temp are encountered, inhibitors to prevent corrosion of oil well casing and tubing during acidizing have become more important. Acetylenic cpds are effective inhibitors.

In this study propargyl alcohol was selected as a standard inhibitor, its structure was altered systematically, and the resulting cpds were evaluated as acid inhibitors. The triple bond was found to be the focal point of inhibition. Substituent groups in the mol affect their basicity and modify their ability to inhibit.

The explanation of these trends provides a new research tool for the study of the mechanism of acid corrosion inhibition. This field holds promise of an additional market for acetylenic chemicals. M. F. M.

1656. How polar type oils inhibit corrosion. R. A. Powers and J. C. Cessna. *Industr. Engng Chem.*, 1959, **51**, 891.—In addition to acting as a diffusion barrier, polar-type oils, through a combined action with dissolved oxygen, inhibit corrosion by promoting passivation of iron and steel.

The inhibitor oil appears to concentrate oxygen at the metal–oil interface and generally provides an environment favourable for oxidn. At the metal–soln interface the oil also prevents breakdown of this passivity under conditions where it might otherwise occur, such as removal of oxygen from soln or the presence of chloride ions. M. F. M.

1657. Corrosion-free electrical installations. R. P. Northup. *Chem. Engng*, 13.7.59, **66** (14), 180.—In chemical and oil plants corrosion is present to some extent in practically all installations. Some of this corrosion is relatively harmless, while others may cause costly shutdowns of the plant. After discussing the advantages and disadvantages of a number of

metals and alloys for electrical installations the paper lists the popular materials in the following way: Cast iron and mild steel—good for alkaline environments but not good for acids. Stainless steel—excellent for severe conditions, use for shafts and push-buttons. Aluminium and alloys—good for salt sprays or sulphur gases, not good for acid fumes. Copper, brass, and bronze—good for alkalis and weak acids, not good for ammonium nitrate or strong acids. Coatings—extruded PVC coatings have wide range of resistance but are not good for temp higher than 150° F. M. F. M.

1658. Prime reasons for metal failures. G. A. Nelson. *Chem. Engng*, 29.6.59, **66** (13), 132.—The paper, which is based on a survey of eight chemical plants and nine oil refineries, traces the main causes of metal failure in process applications and attempts to find an answer to the problem. The principal cases of metal failure are listed as: (1) temp only (embrittlement, graphitization, aging, sigma formation); (2) temp plus stress (creep, thermal fatigue); (3) temp plus gases (air and oxidizing gases, H_2S, CO, V_2O_5, etc.); (4) corrosion only (general corrosion, galvanic corrosion, groove corrosion, etc.); and (5) corrosion plus stress. M. F. M.

1659. New alloy more resistant than titanium. R. B. Norden. *Chem. Engng*, 18.5.59, **66** (10), 200.—Pure titanium is excellent in most oxidizing environments but not good in reducing media such as dilute hydrochloric or sulphuric acids. This situation has changed with the recent introduction of Union Carbide Metals' new titanium alloy (0·1% of a noble metal), which greatly extends the operating range for corrosive service. The noble metal–Ti alloy can be used under process conditions which may go from oxidizing to reducing. Palladium has been preferred as the noble metal, but platinum, gold, rhenium, rhodium, etc., also could be used. The paper includes a corrosion chart as well as economic considerations of the new alloy. M. F. M.

ENGINES AND AUTOMOTIVE EQUIPMENT

1660. Combustion products from diesel engines. 1. (In Italian.) C. Paleari and F. Renzarigo. *Riv. Combust.*, 1959, **13**, 419–31.—Investigations were made on the effect of gas oil composition, the presence of ignition improvers, and of engine operation conditions on the nitrogen oxides and carbon monoxide content of a CFR F-5 engine exhaust gas. With all gas oils (clear and with additives) used during these tests, the highest nitrogen oxide contents were ascertained when running at intermediate loads: the effect of additives was manifest only when running at minimum speeds. Nitrate base additives appeared efficient in reducing the exhaust gas carbon monoxide content, particularly with low cetane number gas oils in engines running on high loads.
(Authors' abstract.)

SAFETY PRECAUTIONS

1661. Halogenated hydrocarbons as extinguishing agents. (In German.) M. Friedrich. *Erdöl u. Kohle*, 1958, **11**, 248–52.—The term halone was applied in the U.S.A. to the chem cpds of the halogenated hydrocarbons. Chemicals, generally liq, are concerned, in which C, H_2, and halogen atoms are combined in one mol. To systematize the large number of possible cpds figures are assigned and the halones denoted with numbers for simplification. Thus CCl_4 has the halone No. 104. Extensive investigations are reported on quenching effect relative to number of halogen atoms/mol, and corrosive effect and toxicity of the cpds. Halones should be used only where costly materials or human lives are at stake. No astonishing results may be expected from their use in fire fighting. Fighting of particular fires, however, is more effective than with previous quenching materials. R. T.

1662. Operational safety through correct illumination in industrial places exposed to explosion risks. (In German.) H. Olenik. *Erdöl u. Kohle*, 1958, **11**, 252–60.—Factors to be observed, which contribute to safety, are explained. Increasing illumination strength under otherwise const working conditions leads to output increase. Decrease in relative fatigue and errors occurs, the latter being extremely important and a min when illumination is correctly co-ordinated to fineness degree. Sources of illumination and safety are discussed with numerous illustrations. R. T.

ECONOMICS AND MARKETING

1663. Outlook for petroleum solvents. P. D. Shuwall and F. D. Johnson. *Oil Gas J.*, 29.6.59, **57** (17), 85.—Solvents offer a premium price over the fuel value of products in the same boiling range, and thus are recognized as profitable materials. But the long-range challenge of synthetic dry-cleaning solvents and use of water in emulsion paints will capture markets from petroleum solvents.

Short-term remedy is to improve specific solvent properties, but long-term policy would be to explore new outlets, and provide more technical service.

A review of the uses of petroleum solvents shows paint industry as by far the largest single consumer, but water-base paints offer serious competition.

There is a demand for high solvent power, with formulation of new coating resins and complex paint formulations which could be met by increased use of aromatics.

Tightening up of fire regulations has led to the use of synthetic chlorinated solvents in "packaged unit" dry cleaning plants.

Economics specify which type of solvent shall be used in rubber industry, as a required degree of solvency and short drying time are real major factors in the choice of solvent.

There is a growing use for petroleum solvents in the herbicide field and in oil-extraction. G. A. C.

1664. Canada's refining picture largely mirrors that of U.S. L. Resen. *Oil Gas J.*, 17.8.59, **57** (34), 130.—The figures are a direct reflection of the refining position in the U.S.A. with a time lag.

Tables show annual consumption in Canada and the U.S.A. 1939–58, source of Canadian crude, imports and exports, sales and production for 1958, and price trends.

Research ON of Canadian house-brand motor fuel exceeded that in the U.S.A. in 1958, and trend continues in 1959, average figures being 91·7 for Canada and 91·3 for the U.S.A., premium grades running at 98·2 and 98·6 respectively.
G. A. C.

1665. Economics of cathodic protection. N. K. Senatoroff. *Oil Gas J.*, 20.7.59, **57** (30), 107.—Average costs for cathodic

protection, including instrumentation, materials, and labour for a project gas line are given, and expensive as against less expensive coatings are compared. It is concluded that the installation and operating costs of cathodic protection in combination with good coating are small and comparable to insurance and taxes. G. A. C.

1666. Sea transportation of petroleum. L. F. Kahle and A. J. Kelly. *Oil Gas J.*, 6.7.59, **57** (28), 106.—It is estimated that out of every ten brl of petroleum consumed in the U.S.A., three or four brl were moved by sea transportation somewhere on route. Of all foreign consumption (except countries within Iron Curtain) eight brl out of ten were by sea, and Europe had 90% depending on such transportation. The outlook for nuclear power tankers is reviewed, showing only one such tanker possibly to be constructed. Tables show oil demand and U.S. tanker use 1918–50, and world oil demand and ocean tonnage utilization during 1950–58. G. A. C.

1667. Midyear report. Anon. *Oil Gas J.*, 27.7.59, **57** (31), 132.—Included in this section, besides drilling information, are figures for worldwide production (the U.S.A. accounts for 43% of the total), U.S. demands for petroleum products up 6% on 1958, crude production up 11·1%, refinery runs up 7·9%, refined products imports highest ever, record gas–liq production, and pipeline construction to surpass 1958 total. A midyear report is given on plant construction (all for the U.S.A.). G. A. C.

1668. United States intensifies quest for foreign oil; Russia expands in world markets during 1958. H. W. McCobb. *J. Petrol. Tech.*, Feb 1959, **11** (2), 14–18.—In Sept 1958 Free World production was a record of 16×10^6 bd, over 9×10^6 bd being outside the U.S.A. Proved world reserves are placed at $225–275 \times 10^9$ brl, the U.S.A. having an interest in 64% of the Free World reserves.

Russia produces more oil than is consumed internally. Export is sometimes on a barter basis, or with price concessions.

Transportation is a vital factor for Canadian oil and gas. Imports are at present made in E Canada.

New tax laws in Venezuela make division of profits of the order of 60 : 40 in favour of the Government. This may lead to loss in vol of oil output, and a lower real income from oil. Spectacular successes have been obtained in Lake Maracaibo, *e.g.* 1000 ft of oil sand, and well potentials of 10,000 bd. Argentina has taken steps to attract foreign oil companies, in the form of agents to produce oil.

Probable reserves at Hassi Messaoud may be $3·5 \times 10^9$ brl, with present output 10,000 bd, but a 24-inch, 412-mile, 240,000-bd pipeline is planned. Zarzaitine is thought to be more promising than Edjele. Gas reserves of the order of 15×10^{12} cu ft have been discovered in Algeria; a pipeline under the Mediterranean is under consideration. Four discoveries have been made by 30 wildcats in Libya.

20 miles E of Das Island in the Persian Gulf a potential new field discovery well was drilled giving 2400 bd.

Gas was found in the Cagayan Valley on Luzon. G. D. H.

1669. Significance of Belayim and other Sinai oil production. A. Melamid. *Internat. Oilman*, 1959, **13**, 222–3.—Belayim crude is the combined product of the Belayim and Abu Rudeis fields on the Sinai peninsula. The oil, of 22·0°–22·9° API gravity, is offered at a lower price than other Middle East crudes, but is undercut by Soviet fuel oil. The concession is owned by two Egyptian companies, the stock of one of which is shared by Petrofina and ENI. The total Egyptian production of oil in 1959 is expected to amount to 70,000 bd, which is more than twice the Egyptian requirements. The surplus will probably not be enough to affect Middle East prices permanently, but the appearance of Belayim on the market confirms the possibility that new discoveries might upset the international price structure. G. B.

MISCELLANEOUS

1670. 100 years of oil. Various. *Times Rev. Ind.* 1959, **13** (151), 65–112.—Series of illustrated brief reviews: "Set" for the second century (C. M. Vignoles, 2 pp.); When the Well ousted the Whale (W. J. Harris, 3 pp.); World Chart of Petroleum Resources (M. J. Wells, 6 pp.); BP's Coincident Jubilee (Anon, 2 pp.); Finding and Winning Liquid Fuels (D. E. Doyle, 2 pp.); Converting Crude to Countless Ends (J. B. Middleton, 2 pp.); Carriage by Land and Sea (F. L. Hodges, 2 pp.); Outlook for the Tanker Fleets (L. C. Musgrave, 2 pp.); Transformation of the Chemicals Field (W. F. Mitchell, 1 p.); American Share in Britain's Interests (J. H. Dunning, 1 p.). V. B.

1671. Century of oil. A. C. Hartley. *Engineer, Lond.*, 1959, **208**, 183–5, 220–2.—Review. Early history, developments to 1956 (oil exploration, oil well drilling, oil production, crude oil transportation, refined products transportation, oil refining, oil loading), developments since 1956, and probable future trends. V. B.

1672. Petroleum industry in 1958. J. Charoy. *Bull. Ass. franç. Tech. Pétrole*, 1959, 663–76.—Review with special reference to France, petroleum consumption of which (19 products) is tabulated for 1956–58 and commented on, with brief survey of production in France and French Union. V. B.

1673. High efficiency in petrol retailing. J. S. Jackson. *Times Rev. Ind.*, 1959, **13** (150), 56.—1958 U.K. figures are 95,000 pumps (av throughput 16,450 gal) with 50 private cars (using 226 gal each) per pump. 69% petrol sales premier grade. V. B.

1674. Large electronic calculators. Refinery applications. — Masson and — Rochery. *Bull. Ass. franç. Tech. Pétrole*, 1959, 385–402.—Brief overall review followed by short survey of refinery use (operation of dist column, programming of refinery operations). V. B.

1675. Petroleum industry and petroleum chemical prospects of the U.S.S.R. T. Reis. *Chim. et Industr.*, 1959, **81**, 619–32.—U.S.S.R. energy data is surveyed, oil 1958 115 m tons, 1965 240 m; natural gas 1958 3×10^{10} m³, 1965 15×10^{10}. Outline (maps and tables) of development of U.S.S.R. petroleum industry and reserves, natural gas supplies and pipeline system. V. B.

1676. The Fifth World Petroleum Congress. Anon. *Petrol. Times*, 14.8.59, **63**, 492.—Summaries are given of papers of particular interest and include: Section II—Drilling and Production; Section III—Oil Processes and Refining; Section IV—Chemicals from Petroleum and Natural Gas, Section V—Composition, Analysis, and Testing; Section VI—Utilization of Petroleum Products; Section VII—Engineering, Equipment, and Materials; Section VIII—Transportation and Distribution; Section IX—Operations and Research, Statistics, and Education; Section X—Application of Atomic Energy to the Petroleum Industry. A concluding section briefly deals with the associated exhibition. G. A. C.

1677. How automobile exhaust gases burn. B. Greifer and T. Sengyel. *Industr. Engng Chem.*, 1959, **51**, 953.—The feasi-

bility of reducing atmospheric pollutants by using non-catalytic afterburners for automobiles depends on maintenance of a flame in the engine exhaust gases. The flammability of a wide range of synthetic gas mixtures simulating automobile exhaust gases was measured in the lab with a flat-flame burner.

Equations and a correlation curve relate the combustibility of automobile exhausts to temp and composition. The results should be of interest to designers of automotive afterburners, to chemical process engineers, safety engineers, and others concerned with combustion of vitiated gas mixtures.

M. F. M.

1678. Costs, allowable rate hinders offshore work. B. Dykstra. *Drilling*, Aug 1959, **20** (10), 65.—Estimates indicate that U.S. continental shelves should contain *ca* 100 billion brl oil. Only 1% of these reserves have been proved. Drilling in water depths of 150 ft has been proved feasible, but most has been carried out in less than 60 ft. A third of all offshore wells were dry holes, and in water deeper than 60 ft 40% were dry holes. Costs increase with depth of water. A well completed at 10,000–11,000 ft in 65 ft of water generally costs not less than $750,000; in deeper water costs of $1 million are no exception. Since a well 10,000–11,000 ft deep is now permitted to produce only 173 bd, a very large capital outlay is needed to obtain a sizeable production. Most of the work offshore is handled by specialist contractors, and contract bill is *ca* 75% of total expense of producing operations.

J. C. M. T.

BOOK REVIEWS

Proceedings of the Third Conference on Carbon. University of Buffalo, July 1957. London: Pergamon Press, 1959. Pp. x + 718. 140*s*.

This volume contains the papers submitted for presentation at the Third Conference on Carbon held at the University of Buffalo in July 1957. The papers, 79 in number, are grouped into five sections entitled respectively "From Benzene to Graphite and to Diamond," "Electronic Properties," "Reactions and Compounds," "Graphitization and Structure," and "Mechanical and Thermal Properties and Carbon Technology." The subject matter of the papers ranges from an exciting account of the first synthetic production of diamonds at the General Electric Co's laboratories by H. T. Hall through a variety of topics concerned with graphite and the physical and chemical properties of carbon black to studies of electron spin resonance in heat-treated organic compounds.

In recent years carbon has become a material of great industrial and scientific interest, particularly in the field of nuclear engineering. Studies of the structure, physical properties, and reactions of graphite, necessary to the elucidation of the behaviour of graphite rods on irradiation, have stimulated interest in the structural properties of all types of carbon. The application of new X-ray techniques to the study of carbonized coals, carbon blacks, and irradiated and ground graphites has yielded information on the macro molecular structure. Further studies on the optical and magnetic properties and on the reaction of black with oxygen, water, etc., illustrate the profound effect that minor modifications in structure can have upon the properties of the material. The papers presented at this conference describe researches into these and related fields.

The publication of the conference papers in book form by the Pergamon Press is itself an indication of the wide interest in this particular subject. Papers presented at the first and second conferences on carbon have been collected and published in a limited edition by the University of Buffalo. Future conferences, to be held biennially, will also be published, making the present book the second of a series of publications which promises to be as important and as much used as the similar publications of the International Conferences on Combustion. In view of the difficulty of obtaining the books of the earlier conferences on combustion, libraries and workers in the field of carbon would do well to ensure their copy of this excellent publication.

F. M.

Steric Effects in Conjugated Systems. Ed. G. W. Gray. London: Butterworths Scientific Publications, 1959. Pp. viii + 181. 30*s*.

It is now becoming more common for the results of scientific research to be recorded through the medium of a specialized publication, such as "Steric Effects in Conjugated Systems," instead of through the usual medium of scientific journals.

This book consists of 19 original papers presented at a symposium held by the Chemical Society at the University of Hull on 15–17 July 1958. It also includes the discussion on these papers, and therefore can be described as a useful guide to the present-day thinking of many of the leading experts in this particular field of chemistry. It should be remembered, however, that only four of the papers originated from outside Britain. Nevertheless, the reader will not have had his thinking done for him as he might reasonably expect in a conventional text-book on the subject. This book, in fact, only eliminates the necessity of working through chemical abstracts in order to collect together the original publications, except that it includes the useful comments of the experts on each others' contributions. Having mentioned this, it must also be said that such a compilation is a very useful thing to have on one's bookshelf if one is actively working in this field, and it is certainly worth persuading a librarian to purchase in case one ever has recourse to inquire into it.

It would, of course, be impossible in a single conference to cover the whole field of steric effects in organic chemistry, but the narrow field chosen has been adequately covered by the contributors. The papers deal in some considerable detail with the study of the steric effects in conjugated systems, and for detailed abstracts of the individual papers the reader is referred to articles contributed by Dr G. W. Gray to *Nature* (1958, **182**, 568) and Dr C. W. Rees to *Chemistry and Industry* (11 Oct 1958, 1316). J. B. M.

ERRATUM

The Oilman's Barrel. It is regretted that in the review of this book on page 146 A (July issue) the equivalent of the U.S. gallon was inadvertently given as 231 cubic metres in the sixth line from the bottom of the righthand column. The correct equivalent is 231 cubic inches.

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OILFIELD EXPLORATION AND EXPLOITATION

GEOLOGY

1678a. Palynology's first ten years as an aid to finding oil. W. S. Hoffmeister. *Oil Gas J.*, 17.8.59, **57** (34), 246.—The uses of fossil pollen and spores in petroleum geology during the past ten years are outlined. Their main uses are for quick dating of sediments, correlation, and zonation, and they have advantages over macrofossils in that, being wind-borne, they occur in almost all types of sediment and, being small, they escape destruction by the drilling bit. As well as spores and pollen other micro-organisms which have proved useful in the industry are the hystrichospherids, dinoflagellates, coccoliths, and microforams. C. A. F.

1679. Synchronous highs: preferential habitat of oil? R. Scholten. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1793–834.—This discussion is intended to focus attention on one specific environment which appears to create conditions especially favourable to all three stages in the natural history of petroleum—origin, migration, and accumulation. This environment is the "synchronous high"—or "hills" on the sea floor present during sedimentation. Their origin may be diastrophic, depositional, erosional, or inherited through compaction or draping, or a combination of these, and they are thought to be preferential habitats of oil and gas. Traps of this type may possess a variety of characteristic structural, topographic, sedimentary, and stratigraphic features which may be found in some cases through field, air-photo, or geophysical methods, but more commonly through careful studies of subsurface samples and logs. E. N. T.

1680. Is there more oil at Titusville? W. M. Small. *Oil Gas J.*, 10.8.59, **57** (33), 144.—Although active research in secondary recovery methods and modern techniques in drilling and

completion methods have helped to stem the decline in production in Pennsylvania, it is important to investigate the prospects for new discoveries, particularly in deeper formations. The geology of the area is reviewed and exploration projects are suggested. It is shown that: (1) much of the Oriskany–Onondaga territory is untested; (2) 80% of the Silurian (Lockport through Medina) is unexplored; and (3) almost all of the Upper Cambrian and Trenton–Beckmantown are unexplored. Samples are scarce in the area, and it is recommended that, in future deep drilling, there should be close sampling and efficient logging. 27 refs. C. A. F.

1681. North Louisiana strike adds four pays. F. J. Gardner. *Oil Gas J.*, 3.8.59, **57** (32), 129.—I S. D. Kennedy in Ouachita Parish, N Louisiana, has found five gas pays in the Trinity and Hosston formations above the target zone in the Jurassic Cotton Valley. The well is *ca* 10 miles S of the large Monroe gas field, and the pay discoveries suggest the possibility of another major gas field in the area. Other areas in N Louisiana continue to offer good prospects with multiple and fairly shallow pays. There is much activity in the old Caddo Pine Island field, where there has been successful fracturing in Cretaceous chalks at *ca* 1400 ft. C. A. F.

1682. Highly complex dome yields many secrets. C. I. Atwater. *Oil Gas J.*, 27.7.59, **57** (31), 250.—The geology of the Block 126 salt dome field, 25 miles offshore from Louisiana, is outlined. The dome has a surface expression with water shallowing from 50 to 18 ft over the crest and the stock penetrates to the sea floor. It is a typical piercement dome with almost continuous peripheral overhang, the stock being *ca* 2 miles in dia at 4000 ft. Folding–fan radial faulting is developed involving Pleistocene, Pliocene, and Miocene beds which contain unconformities. Pays consist of 33 sands ranging from 3000 to 12,800 ft, and the most important reservoirs are Pliocene sands between 4500 and 6500 ft on the NW flank. C. A. F.

1683. Deep wildcat highlights Western McAlester basin. F. J. Gardner. *Oil Gas J.*, 10.8.59, **57** (33), 143.—After many years of intermittent exploration the McAlester Basin in the border area of Oklahoma and Arkansas is being intensively explored, following recent gas discoveries, the promise of outlets, and a 50% success ratio. C. A. F.

1684. In Southwest Michigan Silurian rocks have oil and gas potential. G. D. Ells. *World Oil*, Sept 1959, **149** (4), 88.—The discovery and development of Salina oil and gas fields in Allegan County, SW Michigan, have provided a new exploration target in the area where the main interest has been in the Ordovician Trenton–Black River group. Recent drilling has also given useful data on the Devonian and Upper Silurian structure for part of the area. Salina production has been found in beds beneath or on the flanks of known Devonian Traverse limestone structures, and the geology of the recently found fields is described. Pays are dolomites forming stratigraphic traps. The area is largely unexplored in the Salina, which has three potential oil and gas pays, and there are good possibilities for stratigraphic traps. There are also possibilities for underground gas storage in the area. Eight refs. C. A. F.

1685. Upper Mississippian–Lower Pennsylvanian stratigraphy of Central Montana and Williston Basin. R. P. Willis. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1940–66.—The rock sequence between the black shales of the Heath formation and the carbonates of the Amsden formation (restricted) is known as the Tyler formation and is divided into two members, the division being made at the base of the "A" zone, which consists of the Bear Gulch limestone tongue and its sand equivalent. The upper member is called the Cameron Creek member.

The Tyler formation sand map shows what is believed to have been a normal marine to restricted beach–offshore bar type of depositional environment; this is true both in Central Montana and Williston Basin, but the erosional unconformity at the base of the Tyler formation is evident only in Central Montana. The sands in the lower member of the Tyler formation in Central Montana are called the Sumatra sands; the upper sand in the Tyler–Heath of Williston Basin is termed the Fryburg sand, and the middle sand is the Fritz sand. The age of the Heath formation is believed to be Late Chester; the overlying Tyler formation Early Pennsylvanian (Morrow); and the Amsden formation (restricted) is dated as Morrow-Atoka. E. N. T.

1686. Pennsylvanian and Permian stratigraphy in Sangre de Cristo Mountains between La Veta Pass and Westcliffe, Colorado. D. W. Bolyard. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1896–939.—The Sangre de Cristo Mountains form the southernmost high range of the Rocky Mountain system and are a rugged range rising steeply 5000–7000 ft above the intermontane basins. Between La Veta Pass and Westcliffe there are seven peaks with altitudes exceeding 14,000 ft. The sediments are predominantly arkosic clastics, eroded from Pre-Cambrian crystalline rocks of the San Luis–Uncompahgre highland on the W, and rapidly deposited in a narrow geosyncline trending NW. The terrigenous clastics become fine-grained and Desmoinesian limestones become abundant southeastward, reflecting southward decrease in uplift of the highland and a more basinward position of the S exposures.

The Sangre de Cristo formation, of late Pennsylvanian (?) and probably Permian (Wolfcamp) age, contains up to 8000 ft or more of predominantly fluvial strata. It is differentiated from underlying units by its redbeds. Two members are recognized in the N part of the area; the Lower member, characterized by piedmont cyclothems; and the Crestone conglomerate. The latter, a thick fanglomerate, is the only positive evidence of mountains in the San Luis–Uncompahgre highland, and is the last record of Palæozoic orogeny in this area. E. N. T.

1687. Moenkopi formation (Triassic? and Triassic) in salt anticline region, Colorado and Utah. E. M. Shoemaker and W. L. Newman. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1835–51.—The Moenkopi formation of Triassic (?) and Triassic age, a unit long recognized on the Colorado Plateau, was first delimited in the salt anticline region of SE Utah and SW Colorado; its distribution is that of a blanket of irregular thickness with several large holes in it, due to non-deposition and pre-Chinle erosion.

Four members of contrasting lithology have been mapped in this salt anticline region: (1) the Tenderfoot member, mainly composed of muddy or silty poorly sorted sandstone; (2) the Ali Baba member, composed of interstratified arkosic conglomeratic sandstone and fissile siltstone; (3) the Sewemup member, composed mainly of fissile siltstone with minor beds of conglomeratic sandstone and gypsum; and (4) the Pariott member, composed of interstratified sandstone and siltstone.

Part of the Tenderfoot member of this formation is correlative with the Hoskinnini member of the Moenkopi formation of SE Utah, a unit which may be either Permian or Early Triassic, or possibly both. If any of the beds in the Moenkopi in the salt anticline region are time equivalents of type Moenkopi they are probably in the Pariott or upper part of the Sewemup member. E. N. T.

1688. Stratigraphic relations of Hoskinnini member (Triassic ?) of Moenkopi formation on Colorado Plateau. J. H. Stewart. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1852–68.—Recent work on the Colorado Plateau on strata of Permian and Triassic age indicates that the unit originally defined as the Hoskinnini tongue of the Cutler formation extends into parts

of SE Utah not previously reported. Also the Hoskinnini is correlated with part or all of the unit defined as the Tenderfoot member of the Moenkopi formation in the salt anticline region of E–Central Utah and W–Central Colorado. It is now proposed that the Hoskinnini be redefined as the Hoskinnini member of the Moenkopi formation. This member and laterally continuous strata in the Tenderfoot member are exposed within a NNE oriented area *ca* 180 miles long and 50 miles wide extending from the Monument Valley area, in NE Arizona and SE Utah, to W–Central Colorado, and are pale reddish brown sandy siltstone grading to silty very fine-grained sandstone and contains disseminated fine, medium, and coarse quartz grains.

The Hoskinnini is 50–120 ft thick in most areas and is composed of horizontal beds, the individual beds being marked by indistinct discontinuous wavy laminæ bounded by greyish red claystone or siltstone films. E. N. T.

1689. Origin of salt anticlines of Paradox Basin. R. W. Jones. *Bull. Amer. Ass. Petrol. Geol.*, 1959, **43**, 1869–95.—This paper presents evidence to support the idea that the salt anticlines were initiated by the differential loading of the salt-bearing Pennsylvanian Hermosa formation by the Permian Cutler formation; previous investigators had attributed them either to compressional folding or to deep-seated faulting. Evidence to support the former theory includes the following: (1) the necessary stress was available; (2) many of the individual features of the anticlines are in agreement with theory and experiments based on a differential loading hypothesis; (3) the time of origin of the anticlines is as predicted by the differential loading hypothesis; and (4) the anticlines probably formed in sequence from NE to SW as required under a differential loading hypothesis. E. N. T.

1690. Dry hole even boosts Iowa's oil play. R. S. Enright. *Oil Gas J.*, 27.7.59, **57** (31), 100–1.—A recent dry hole in Mills County, Iowa, has increased interest in drilling this so-far unproductive state, owing to excellent porosity found in formations from 1000 to 2236 ft. Iowa has not previously been regarded as favourable for exploration because of basement only 3500 ft down and blanket of *ca* 150 ft of glacial drift. Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, Cambrian, and pre-Cambrian rocks are present. Principal structural features are the Nemaha Ridge–Table Rock Uplift, separating the Forest City and Salina Basins, and the Richfield Arch. Good reservoir conditions are indicated by the new well in the Hunton Lime, the St Peter Sand, and the Viola and Arbuckle formations. Several test wells, including the latest, have had minor oil shows.
J. C. M. T.

1691. Vast marine basins being explored in South America. Pt 1. C. A. Moore. *World Oil*, Sept 1959, **149** (4), 78.—There are large sedimentary areas in S America which are untested, although some parts have proved to be richly productive. The geological history of the continent is outlined with a series of palæogeographical maps showing depositional areas in the Lower Palæozoic, Upper Carboniferous to Trias, Jurassic, Cretaceous, and Tertiary. The broad lithology of the formations in each of these periods is outlined. In the Lower Palæozoic the beds are unmetamorphosed immediately to the E of the Andes, and dark shales may be possible source rocks. In the Upper Palæozoic to Trias there has been significant production from Permo-Carboniferous tillites in anticlines in S Bolivia and N Argentina. Jurassic marine shales are believed to be important source rocks. Cretaceous and Tertiary rocks have yielded very important amounts of oil in Venezuela, Colombia, Ecuador, Peru, and elsewhere.
C. A. F.

1692. Stratigraphic and palæographic results of recent micropalæontological investigations in the Tertiary of the Rhine Valley trough. (In German.) F. Doebl. *Erdöl u. Kohle*, 1958, **11**, 373–6.—The Rhine Valley trough—as illustrated—which extends between Basle and Frankfurt, is filled preponderantly by tert sediments which may be up to 3500 m thick. The heavier sedimentation occurred in the S of the trough during the period of Lymnean marl and Pechelbronn strata. Ever less brackish and marine intrusions are found towards the N. Pervading brackish-marine horizons are observable only in the Lymnean marls and in the middle Pechelbronn strata. During the separate time periods deposition conditions in the Gray strata series were very similar over the whole trough, thus permitting good comparions of the fauna horizons. Aquitanian is the most strongly developed in the N and middle of the Rhine Valley trough. Brackish-marine forms decrease strongly towards the S, especially S of Karlsruhe. Clear facies differences appear both in N–S and E–W extensions. So the fauna of the trough edge and interior are strongly differentiated. 10 refs. R. T.

GEOPHYSICS AND GEOCHEMICAL PROSPECTING

1693. Radioactivity surveys—here's how they could uncover oil. W. D. Crews. *Oil Gas J.*, 3.8.59, **57** (32), 130.—A new hypothesis to explain radioactive surface anomalies above oil and gas accumulations is presented. It is suggested that, at any given time, a "bank" of radioactivity from dispersed radioactive sources, of fairly even intensity, is moving towards the earth's surface. When the "bank" passes through an overlying hydrocarbon accumulation it loses some of its energy (due to radioactivity dissipation with transmission of internal energy). Above the accumulation a new "bank" begins to form from new radioactive source material, its areal extent assuming the shape of the oil reservoir. At the surface the γ-ray intensity will be lower than that in the surrounding area away from the accumulation by an amount equal to the energy lost in the oil zone. Haloes have been found at oil–water contacts, and several explanations are offered, *e.g.* a mechanism similar to secondary enrichment of ore deposits may concentrate radioactive materials at the interface. 17 refs. C. A. F.

1694. Geological and geophysical investigations in the Saar-near-syncline. (In German.) J. Andres. *Erdöl u. Kohle*, 1958, **11**, 441–50.—A geophysical measuring programme carried out in the Wintershall AG concessions in the Palatinate from 1952 to 1957 provides interesting information, described and presented in an extensive series of maps. Structures determined by seismic reflection between the Saar and Lemberg regions coincide well with the known course of the saddle axis. Besides the pre-Upper Carboniferous underground, the basin filling of the recent Palæozoic rocks is reflected again in the gravimetric measurements. Investigations indicate that a special gravity effect must be attributed to the sandstones, shales, and conglomerates of the Lower Permian of Germany, which overstamps the gravity effect of the base formation and makes difficult interpretation of the gravimetric results. Estimation of rock densities in drilling cores has proved valuable for recognizing this overstamping. On the basis of the geophysical investigations of drilled wells quite thick lower red sandstones and, in the case of Olm 1, also thick upper red sandstones could be detected. The lower red sandstones could be especially interesting for petroleum prospecting. Nine refs. R. T.

DRILLING

1695. Lost circulation—and how to prevent it. J. R. Eckel. *Oil Gas J.*, 20.7.59, **57** (30), 96–8.—Subnormal pressures and incipient fractures make the Anadarko Basin particularly

subject to lost circulation, but this can be successfully combated by a suitable prevention programme aimed at reducing pressures in well during drilling operations. 7⅞-inch hole is drilled with 4½-inch pipe, leaving a third more annular space than 3¾-inch hole drilled with 3½-inch pipe, therefore giving lower pressure drop. Visc of mud is kept low an / de-sanders used to keep solids down, resulting in lower pumping and surge pressures. Pipe lowering speed limited to 1 stand/min almost eliminates surges. J. C. M. T.

1696. How to combat lost circulation while cementing. Pt 1. A. J. Willis and R. A. Wynne. *World Oil*, Sept 1959, **149** (4), 69.—There are three main problems caused by lost circulation during cementing: (1) communication between zones not properly sealed with cement; (2) corrosion of exposed pipe; and (3) difficult production from an upper zone because of unsatisfactory cement covering. Two general methods which can be used separately or together are available for combating cement loss, and the aim is to reduce density and visc so as to prevent breakdown of formation across the cementing interval. Lightweight cement can be used, incorporating bentonite, and diatomaceous earth has also been successful. If the formation contains existing fractures, binding materials can be mixed into the slurry. C. A. F.

1697. Low-density cement–lost-circulation slurry—Gilsonite gives both. K. A. Slagle and L. G. Carter. *Oil Gas J.*, 10.8.59, **57** (33), 109–14.—The naturally-occurring solid hydrocarbon Gilsonite was first used as a density-reducing additive in cementing slurries because of low sp gr (1·07) in 1957. Since then it has been used in more than 200 cementing jobs. Advantages include inertness to formation waters and cement, adequate strength to allow particles forming bridge to withstand moderate squeeze pressures but soft enough to form good seal, and, being without voids, no increase in density occurs at high pressure. For given density reduction of slurry, cement is not weakened as much as when reduction is obtained with excess water. Cements appear not to suffer from solvent action of oils, and bottom hole temp up to *ca* 300° F probably do not cause difficulties. Examples of applications in Texas, Arkansas, New Mexico, and Kansas are described. Optimum concn seem to be 25–50 lb Gilsonite/sack of cement. J. C. M. T.

1698. Diatomaceous earth cures lost circulation in cementing casing. A. J. Willis and R. A. Wynne. *Oil Gas J.*, 3.8.59, **57** (32), 78–84.—Excessive cement slurry densities can cause formation breakdown and lost circulation leading to a poor cementing job. There is a limit to the reduction of slurry density (*ca* 15·4 lb/gal) that can be obtained simply by greater dilution with water, as excessive water–cement ratio leads to formation of water pockets and weak zones. An early method of lightening slurries was addition of bentonite, but such cements are attacked by corrosive waters. Perlite, also used, is unsatisfactory, since it collapses under pressure. A better method is addition of diatomaceous earth, which is resistant to attack. Cements with up to 60% diatomaceous earth and density of only 10·2 lb/gal have been used successfully. All low density cements are weaker than neat Portland, but strength required is much lower than was once thought. Cements with diatomaceous earth have much better perforating characteristics than normal Portland cements. When formation contains natural fractures, bridging materials may be incorporated in diatomaceous earth–Portland cements. Field case histories are discussed. J. C. M. T.

1699. New calcium-treated muds slash South Louisiana drilling costs. J. A. Gill and W. M. Carnicom. *Oil Gas J.*, 6.7.59, **57** (28), 102–5.—*Ca* 70% of muds used today in coastal Louisiana are calcium treated, and trend is away from older lime muds towards highly inhibited types. Benefits of these newer muds are immunity to high temp, better hole condition, less visc increase from drilled solids, greater tolerance to contaminants, and less damage to productive sands. The desirable physical condition of the particles in these high Ca, highly-inhibited muds is described as deflocculated but aggregated—this state gives low gel strength, low filtration rate, and a firm cake. Benefits of using mud at its minimum attainable plastic visc and yield point are: better hole hydraulics, faster penetration, less trip gas and hole bridging due to swabbing action, less pressure surge and loss of circulation on re-entering, and reduced mud-maintenance costs. Cost of mechanically removing undesirable drilled solids from mud system depend on amount of barite lost in process, chemicals lost, and rental of separating plant. In any but lowest density muds the decanting centrifuge gives lower cost for solids removal than cone-type separator or water dilution, and saving increases with mud density. J. C. M. T.

1700. Sonic log applications in West Texas and New Mexico. M. E. Curry. *Oil Gas J.*, 3.8.59, **57** (32), 73–7.—Following a review of the principles of the sonic log, some aspects of its application to areas of W Texas and New Mexico are discussed. Many wells in SE New Mexico were completed prior to 1945 in several hundred ft of open hole with pay zones heavily shot with nitroglycerine, resulting in variation in hole size leading to unsatisfactory electric logging; completion records are meagre. Evaluation of net pay thickness and porosity was therefore a problem, to which sonic logs may provide a solution. Best results have been obtained when spacing between transmitter and receiver is 5–6 ft and spacing between receivers 2–4 ft. Other applications include porosity assessment of Permian and Pennsylvanian sands of some Permian Basin Platform fields, where natural radioactivity distorts radioactive logs. J. C. M. T.

1701. In Oklahoma, Kansas, sonic log proves valuable porosity tool. H. E. Pickhardt and L. M. Holley. *World Oil*, Sept 1959, **149** (4), 65.—The sonic log is proving a valuable logging method in the Mid-Continent area, where it is being used for correlation and estimating porosity. The log can be run under a wide range of conditions. Details of the tool are given; it records transit time *v.* depth, times being plotted in microseconds/ft depth. Two spacings are available, 1 ft and 3 ft, and the tool is run in a filled borehole. In order to use the log for porosity estimation the equipment must be accurately calibrated, and the determination is based on a time average relationship:

$$\frac{1}{V} = \frac{\phi}{V_\rho} + \frac{1-\phi}{V_m}$$

where V = average formation velocity, ft/sec; V_ρ = velocity in interstitial fluid, ft/sec; V_m = velocity in the rock matrix ft/sec; ϕ = fractional porosity. The log is focused and formation changes record sharply. Correlations are generally good, particularly in evaporite sections, which are not easy to correlate with other types of log. The log also gives information for geophysical purposes, and total travel time determination is available. Examples of sonic logs are given. Three refs. C. A. F.

1702. How to select and maintain drilling generators. O. J. Graham. *World Oil*, Sept 1959, **149** (4), 83.—Factors which should be considered in selecting a generator for a diesel electric drilling rig are: (1) general characteristics; (2) simplicity of the excitation system; (3) construction; (4) size, weight, and rating; (5) cost; (6) reliability; and (7) availability of parts and service. There are three main types of generator: shunt, series, and compound, and the characteristics of these are briefly described. Construction is basically either the single-bearing, close-coupled type or the two-bearing, foot-mounted

type; the former is smaller and lighter, but both types have advantages and disadvantages which are discussed. For a given generator size and assuming equal production quantities, the single-bearing type should cost less than the other. Costs are effected by generator production rates.

Problems in general maintenance and overhaul are outlined. Diagrams show the schematics and characteristics of three general-type dc generators. C. A. F.

1703. 1959 count finds more, bigger, and busier rigs. W. E. Scarborough. *Drilling*, Sept 1959, **20** (11), 89.—2820 out of 3602 rotary rigs available in the U.S.A. and Canada in mid-1959 were working, compared with 2230 out of 3549 in mid-1948. Contractors now own 93·59% of the rigs, instead of 92·67% in 1958. During the year 46 additions have been made to rigs rated for 16,000 ft and deeper, 26 additions to the 13,000–15,000-ft class, and 36 to the 10,000–12,000-ft class. There were 93 more IC-engined units, five more electric, and 45 less steam. Tabulated data by regions are given.
J. C. M. T.

1704. Drilling for oil in 1975. (The Atlantic Lectures of the University of Texas. Pt 6.) R. O. Childers. *Petrol. Engr*, April 1959, **31** (4), B19.—The author's prophecy is that during the next 15 years the depth of U.S. oil wells will double and the problems associated with drilling these wells will be multiplied several times. The present techniques would be inadequate, new " miracle " muds will become necessary, and the problem of portability and transportation of the complete rig suitable for completion of a 50,000-ft well, weighing, perhaps, 2000 tons, would be very complex. M. F. M.

1705. Needed: closer supervision of equipment used for blowout prevention. F. L. Walker. *Oil Gas J.*, 27.7.59, **57** (31), 171–5.—Too few operators extend their supervision of blowout prevention equipment after actual installation on the wellhead. Checking, testing, and servicing the equipment is expensive and time-consuming but necessary. Ideally, the responsibility for choice, installation, and maintenance should rest with one individual. Bladder-type control heads are liable to unpredictable rupture. Mechanical ram-type gate furnished with air motors, a plentiful reserve air supply, and control from strategic points is still one of most effective systems. J. C. M. T.

1706. Air drilling—what does it cost? How successful is it? G. Jackson. *Oil Gas J.*, 20.7.59, **57** (30), 99–100.—Figures relating to 419,407 ft of hole drilled by air in 226 wells are presented. Average cost for air drilling was $1·37/ft. Where no water was encountered footage cost decreased to $0·77. Of the 226 wells, reversion to conventional mud drilling was necessary in 15% of cases due to water, but in 48·7% fluid invasion was successfully overcome by air drilling using mist or foam techniques in some cases. 36·3% of the jobs were drilled with air alone to total depth. Air drilling should be considered for every well on its merits, as there may be a potential saving, even if only part of the hole can be air drilled. J. C. M. T.

1707. Operators in Rockies drill with air and bank savings. R. W. Sneed. *Oil Gas J.*, 20.7.59, **57** (30), 101–4.—Air drilling has been employed in almost every major Rocky Mountain basin, and big savings made in rig time, number of bits used, and drilling fluid used. Other advantages include: analysable samples return to surface quickly; drilling breaks can be determined as well as with any other drilling fluid; fluid zones can be located precisely and flow rates measured without resort to DST; there is little contamination of producing fluids; climate has little effect on air drilling costs. Savings have been made by use of hard-formation bits in soft formations. Practice on hitting water zones used to be to make a trip to check bit and see if cuttings were building up on drill pipe, but it is now found better to stay in hole and drill ahead to save time during which shales might otherwise hydrate and heave. Some anomalous hydrocarbon and water indications have been noted on electric logs run in fluid-filled holes previously air-drilled. Costs and conditions of several field cases are discussed. J. C. M. T.

1708. New tool holds cement for big fracture repair. B. E. Yester. *Oil Gas J.*, 6.7.59, **57** (28), 129.—Most serious lost circulation occurs when large fractures or caverns are encountered and even cementing fails due to loss of cement before it has time to set. A new tool is described which retains cement in the lost circulation zone until set. It consists of a nylon bag attached to outside of plastic pipe with suitable connexions and stabilizers. Cement is pumped and fills space between tube and bag, expanding bag to hole size. After cement has set all parts of tool may be drilled out. Has been successfully tested in Madison Limestone of Rocky Mountains area. J. C. M. T.

1709. New formation sampler reduces operational costs. W. E. Hyde. *World Oil*, Sept 1959, **149** (4), 63.—A new type of formation sampler forming part of the drill string has been introduced. It consists of two main parts: (1) a packer unit in the drill string which isolates the formation, containing an inflation type packer, sleeve valve, and closing spring; and (2) a retrievable sampler with a pressure bleed-off valve, a hydraulically-operated sampler valve, and a BT pressure recorder. The packer is placed *ca* 3 ft from the bit, and when sampling is required the drilling bit is lifted off bottom hole and the sampler unit is introduced into the drill pipe at surface and allowed to fall freely. The bit is lowered to bottom hole and pressure is applied which causes the packer to expand under internal pressure. Increasing pressure then causes the sampler valve to open, and formation fluids can flow through the bit into the sampler, which is afterwards recovered by wire line. The sampler has a vol of 0·9 gal. The tool has been used successfully in Texas. Diagrams show the mechanism of the equipment. C. A. F.

1710. Casing failures. L. C. M. Darling. *World Oil*, Sept 1959, **149** (4), 99.—Casing failures are due to three primary forces: bursting, collapse, and tension; and secondary causes are crushing, wear, erosion, buckling, and other mechanical effects. High level techniques are now available for repairs after failure; these include cement or plastic squeezing, fluid-seal patching, setting a packer, and lining the casing. Failures can be eliminated by efficient inspection, hydrostatic pressure testing, γ-ray analysis, and other methods. Some obvious indications of failure are: (1) decrease or loss of production; (2) gas or water influx; and (3) loss of casing and/or tubing pressures. Most failures are based on comparisons with nearby wells. C. A. F.

1711. Use of nitrogen in drill-stem testing. A. W. Smith. *Petrol. Engr*, May 1959, **31** (5), B37.—Compressed nitrogen was first used a few years ago to minimize plugging action and sticking of anchor in drill-stem testing in unconsolidated and soft formations. Since the initial introduction, many new uses have been developed for nitrogen, and it has become a major product in the petroleum industry. It can now be advantageously used as a control blanket in drill-stem testing, providing uncontaminated samples, surface control of pressures, and positive protection of drill-stem. Nitrogen can also be used for detection of leaks in surface equipment, as a tracer in water flooding operations, and for displacing fluid from the annulus at the surface of gas injection wells for safety reasons.
M. F. M.

1712. Water + fluid-loss reducer = good workover, cleanout fluid. F. O. Jones and J. L. Lummus. *Oil Gas J.*, **57** (29), 122–9.—Fluid-loss reducers consisting of a vegetable gum and

a mix of starch and bentonite make clear water an excellent fluid for completing, reworking, or cleaning wells. In field tests some wells would not stand full of untreated water, but when fluid-loss reducer was added it was possible to circulate. The treated water is effective over a wide range of formation permeabilities, with or without oil saturation, whether clay is present or absent in formation, and does not significantly affect productivity. Concn of additives ranges from 0·05 to 0·15% by wt. Field and lab tests are described. J. C. M. T.

1713. Hydrogen-bomb-tritium as indicator for injected water in secondary oil recovery. (In German.) H. von Buttlar. *Erdöl u. Kohle*, 1958, **11**, 376–8.—Tritium as a water indicator has the advantage of longer half-life period, practically no radiation danger, small absorption in the rock, immediate availability without direct costs, owing to hydrogen bomb explosions. A disadvantage is the complex detection procedure for tritium. Water which fell as rain before 1954—unmixed with more recent water—can be distinguished by a single tritium analysis. This distinction is used successfully in connexion with sec oil recovery by water injection. Interpretation of the tritium val is simplified by further hydrological knowledge of the region. Such a measurement was carried out in a well producing petroleum and water in Wyoming, U.S.A. The water produced showed at least 80% of recent origin and apparently was identical with the injected water. 10 refs. R. T.

PRODUCTION

1714. Production research picks up speed. R. J. Enright. *Oil Gas J.*, **57** (30), 48–50.—Texas Petroleum Research Ctte at Univ of Texas is conducting research on solution gas drive using a model reservoir. It is hoped to discover production optimum rate, best time to flood, and also data on miscible drive for solution gas drive pools. Model consists of layer of sandstone 6 × 1 inches by *ca* four sand grains thick, resin-cemented between glass slabs, connected for longitudinal flow of fluids (up to max pressure of 10,000 psi), and immersed in air bath with temp control to within 0·1°. Brine and kerosine saturated with methane, dyed for visibility, are used in experiments (crude oils will be used later), the " reservoir " being illuminated from behind and filmed on colour film at 64 frames/sec, later projected at 16 frames/sec. Method by which gas comes out of solution and whether or not nucleation surface is required will be studied. Films may ultimately be used for educational purposes. J. C. M. T.

1715. Carbon dioxide gas increases oil output. A. Gibbon. *World Oil*, 1.8.59, **149** (2), 100.—CO_2 is being used in a 240-acre secondary recovery project in Washington County, Oklahoma. It is mixed with input flood water at the sand face, using a macaroni tubing string down the wells, and it is claimed that the method increases flood efficiency and the injectivity of the input wells. It can also be used as a tertiary recovery method after flooding by conventional techniques. The flood is being applied to the Bartlesville sand at *ca* 1300 ft, with an average thickness of 33 ft. Porosity averages 18% permeability 50 mD, and connate water 41%. During the last six months of 1958 production was increased by 2000 brl/month. The additional cost due to the CO_2 is estimated at a nominal ¼ cent/brl of water; it is manufactured on site from natural gas. C. A. F.

1716. How to produce high pour point, waxy crude. J. J. Dremer. *World Oil*, Sept 1959, **149** (4), 94.—Problems in producing high pour point waxy oil in the Red Wash field, Utah, have been successfully overcome by using: (1) bottom hole heaters; (2) paraffin scrapers combined with rod rotation; (3) hot oil treatments; (4) steam phase line heaters; and (5) electric heating cables. These techniques should be applicable to other areas with similar producing problems, and details are given. The field produces from Green River sandstone at 5500–6000 ft and yields 28° oil with an average pour point of 95° F. Bottom hole temp is 125° F and wellhead temp varies between 60° and 70° F. C. A. F.

1717. Injection pattern sweep-out efficiency. (The Atlantic Lectures of the University of Texas. Pt 8.) B. H. Caudle. *Petrol. Engr*, June 1959, **31** (6), B34.—In order to determine the secondary recovery from a reservoir during " flushing " with a fluid, it is necessary to know: (1) the displacement efficiency, and (2) the fraction of the reservoir which will be invaded by the injected fluid. An example given shows that the unswept area even in a homogeneous reservoir can be considerable. The fluid mobility (= rock permeability/fluid visc) has an important bearing on the efficiency of sweep-out. A means of studying sweep-out efficiencies of various injection patterns using X-ray analysis of reservoir models is outlined. The increased knowledge obtained by this technique has proved helpful in production practice. G. D. F.

1718. Graphical solution to fluid-coning problems. C. P. Rosales, J. H. Vera, and E. G. L. Mendoza. *Oil Gas J.*, 10.8.59, **57** (33), 101–5.—Graphs and nomographs are provided for the computation of potential distribution in both non- and partially-penetrating wells, based on theory of coning of Muskat and Wycoff. Determination of max pressure drop without water or gas cone breakthrough can be obtained. J. C. M. T.

1719. Gas lifting through the annulus of a well. A. L. Benham and F. H. Poettmann. *Petrol. Engr*, July 1959, **31** (7), B25.—The paper describes a calculation procedure for the logical design of a gas lift installation where the flow occurs through the annulus between the tubing and casing of the well. A general energy balance is obtained, which can be used to produce charts of pressure gradient *v.* mass flow rates for use in the calculations. The design procedure describes the method of calculating the optimum depth and injection pressure, and the lift-gas pressure required at the well-head. A worked example of the method of calculation is given. G. D. F.

1720. Here's how to improve your gas lift installations. Pt 2. Simplified method for constructing gas pressure at depth curves. H. W. Winkler. *World Oil*, Sept 1959, **149** (4), 73.—A simplified method for constructing curves showing gas pressure at depth is presented for use in gas lift installations. These can be rapidly calculated, assuming that the increase in pressure due to the gas column is a straight line, and this is satisfactory for most gas lift calculations. Two injection gas pressures at depth, based on max and minimum injection gas pressures encountered during unloading and lifting of a well or group in the same system, are calculated to establish a set of curves. An example of the procedure is given and a series of charts showing compressibility factors for natural gas, and gas pressures *v.* depth are included. C. A. F.

1721. How to interpret and analyse water-flood curtailment data. C. F. Weinang. *Oil Gas J.*, 20.7.59, **57** (30), 92–5.—The statistical method of least squares was used to fit a decline curve to production data from a typical Bradford reservoir on water injection which had, however, been interrupted due to pump failure for six months in 1942. A smooth curve drawn through points plotted from the production data prior to using the mathematical approach showed no change in decline rate as a result of the pause in injection. The curve mathematically fitted to the pre-failure data showed, on the contrary, that the ultimate recovery will in fact be higher than would have been expected if no break in injection had occurred. J. C. M. T.

1722. Radioactive wastes may become future oil-recovery tool. R. J. Enright. *Oil Gas J.*, 13.7.59, **57** (29), 72–4.—Research at Univ of Texas on action of γ-rays released by cobalt-60 suggests fluid radioactive wastes injected into abandoned gas reservoir and left *ca* 30 years may convert it to a commercial condensate reservoir. Effects of γ-rays on various simple hydrocarbons have been tried, *e.g.* in three weeks methane was converted to following gaseous products: 75% hydrogen, 14·2% ethane, 6·7% propane, 2·4% ethylene, *ca* 1% butane; also 24% of the methane was converted to liq heavy hydrocarbons. Work continues. J. C. M. T.

1723. Oilfield development. Pt 3. Well logging. C. A. Fothergill. *Petroleum, Lond.*, 1959, **22**, 219.—The purpose and different methods of well logging are discussed in this article. The simplest types of well log are usually obtained by making observations at intervals and compiling a record during or after the well has been drilled. An example of this is the sample or graphic log which has been described in a previous paper. Another simple type of log is the drilling-time log, which gives a record of drilling speed or rate of penetration. A third simple method is the so-called driller's log, which is a depth record made by the driller of the types of beds encountered in drilling. Electric logs have been used in the industry for the past 30 years, and most oil companies use this type of log as routine in development wells. The log has two main functions: (1) to provide a continuous record of the beds penetrated; and (2) to give information about the fluids contained in porous beds. It is possible to estimate the amount of oil or gas present from electric log characteristics. The method of obtaining electric logs is described.

Other methods described are the S.P. log, the acoustic log, the temp log, the induction log (a recent development), the γ-ray log, and the caliper log. Logging in any form is designed primarily to extract as much information as possible from the borehole, and the current trend is to use the logs increasingly for quantitative purposes. M. F. M.

1724. Improved accuracy in porosity determination. A. A. Brown. *Petrol. Engr*, May 1959, **31** (5), B92.—Microlaterolog, a device for measuring borehole resistivity, was first introduced in 1952 and has since proved to be more accurate than the earlier microlog for determination of formation factor and porosity. The microlaterolog determines formation factor and porosity of a reservoir rock from resistivity measurement of the flushed zone surrounding the borehole (R_{xo}). The formation factor (F) is calculated using the following relationship:

$$F = \frac{R_{xo}}{R_{mf}} \times S_{xo}^2$$

where R_{mf} is mud filtrate resistivity and S_{xo} the water saturation of flushed zone. Porosity (ϕ) is then estimated from the formation factor using Humble's formula:

$$\phi = 0{\cdot}80\ F^{-0{\cdot}46}$$

Comparisons of mud cake thickness as determined by the microlaterolog and the microlog are made in the paper and the effect of thick mud cake on microlaterolog is discussed. M. F. M.

1725. Development and evaluation of gas-condensate reservoirs. Pt 2. W. C. Goodson. *Petrol. Engr*, May 1959, **31** (5), B66.—This article presents examples of reserves calculations and determination of gross value of recoverable reserves. The reservoirs are assumed to have the same thickness, water saturation, and porosity, each reservoir having an initial liq content of 22·0 brl/MMCF. The compositional properties of each reservoir are also assumed. Recoverable products, gas in place, condensate in place and condensate recoverable, and the gross value of recoverable reserves are then calculated. M. F. M.

1726. Engineered hydraulic fracture treatments. Pt 1. D. D. Hunt and H. R. Crawford. *Petrol. Engr*, April 1959, **31** (4), B78. This paper presents a simplified field-adapted method for designing fracturing operations. Basically the technique is that presented to industry in a paper by G. C. Howard and C. R. Fast at the API meeting in 1957 and entitled " Optimum Fluid Characteristics for Fracture Extension." The technique involves rigorous mathematical derivations from simple justifiable assumptions. Calculation of fracture area provides a yardstick for designing optimum fracturing programmes, including consideration of fracturing fluids, fluid vol, injection rates, and sand quantities. M. F. M.

1727. Stimulation treatment: selectivity through perforation ball technology. R. W. Brown and R. G. Loper. *Petrol. Engr*, June 1959, **31** (6), B82.—The article outlines the principles and procedures for obtaining a successful ball sealer treatment. The conditioning of the well, selection of the ball sealer, and factors affecting the efficiency of the ball sealer are dealt with. Finally, a method for the design of ball sealer treatments is given, with some worked examples. Though this design procedure is not a perfected science, results indicate that by using this information treatments can be significantly improved. G. D. F.

1728. Evaluation and selection of fracture propping agents. J. L. Hewitt, B. B. McGlothlin, and J. F. McDonald. *Petrol. Engr*, June 1959, **31** (6), B65.—In the past, sand has been used to prop open the fractures produced in hydraulic fracturing. The theory of the load-carrying capacity of propping sand is dealt with. Experiments were carried out on the flow capacities of fractures propped with: (1) sand; (2) sand, the grains of which were coated with elastic envelopes; (3) organic materials (crushed shells and seeds). Under high loadings the sand crushed, and was unsatisfactory. The coated sand also crushed, but because of the coating formed an excellent prop. Crushed shells also gave satisfactory results, but not crushed seeds. It was necessary to use rounded particles of crushed shells for best results. Both lab and field tests using rounded crushed black walnut shells are reported. Satisfactory results were obtained with no inherent operational difficulties. G. D. F.

1729. A practical approach to choosing a fracturing fluid. V. C. White. *Petrol. Engr*, June 1959, **31** (6), B56.—The tendency of the fracturing fluid to leak out of the fracture and into the matrix is important. Three types of leak-off control are possible. (1) Choice of fracturing fluid of suitable visc. (2) Making use of the fluid resistance of the formation. (3) Addition of additives to the fracturing fluid which build a " filter-cake " on the matrix. The first two methods are dependent on the characteristics of the formation being fractured; the third method is independent of the formation, and gives a more dependable method of increasing the fracturing efficiency. G. D. F.

1730. Increased fracturing efficiency by fluid loss control. J. B. Stewart and A. W. Coulter. *Petrol. Engr*, June 1959, **31** (6), B43.—The visc control, reservoir fluid control, and fluid loss control methods of preventing excessive leak-off of fracturing fluid are described. The paper deals specifically with the last method. Fluid-loss additives are used to form a relatively impermeable barrier which prevents escape of the fluid into the reservoir matrix. Three types of additives have been used: (1) asphaltic—these can be used with all oil-base fracturing fluids; (2) natural and synthetic gums—these can be used, as hydrosols, in aq fracturing fluids; (3) insoluble additives—the effectiveness of these depends on the particle size and the use of a suitable gelling agent. A test for determining the fluid leak-off is described. To obtain a max productivity increase by fracturing treatment damage to the

matrix permeability must be avoided. Fluid-loss additives are effective by keeping penetration by the fluid small. Calculations based on Darcy's law in support of this are appended. G. D. F.

OILFIELD DEVELOPMENT

1731. New fields spur gas search along Texas Gulf Coast. D. E. Lambert. *World Oil*, Sept 1959, **149** (4), 113.—The recent discovery of two important gas condensate fields in Jefferson County on the Texas Gulf Coast has encouraged the search for downdip Hackberry production in this area. The fields are Port Acres and Port Arthur, which both produce from the Frio Lower Hackberry between 10,000 and 12,000 ft. Port Acres has an estimated reserve of 500 billion cu ft and has been largely drilled up; there are 26 producing wells. Port Arthur has a comparable reserve, but the field limits have not yet been determined. C. A. F.

1732. Green County sparks 500 ft drilling boom in Central Kentucky. J. M. Barnes. *Oil Gas J.*, 20.7.59, **57** (30), 138.—The discovery of new shallow oil production in Green County, Kentucky, has encouraged intensive leasing and drilling activity in the area, and 350 cable tool and rotary rigs are operating. The field now contains *ca* 1500 producing wells within a productive area of 9000 acres, extending *ca* 20 miles in length and 2–3 miles in width. Pays are mainly porous lenses within the Middle Cretaceous Laurel limestone at less than 500 ft in depth. There is no clear oil–water contact, and a high porportion of water is produced with the oil. Oil production averages only 30 bd/well, and total field production is *ca* 45,000 bd. Drilling costs average $3.75/ft, and the average oil well costs between $8000 and $11,000 to drill and complete. Production seems to be under solution gas drive, with porosity averaging 17% and permeability 300–2000 mD. Oil is 43° gravity. Salt water presents a major disposal problem, and disposal pits and wells are used. C. A. F.

1733. Simonette River bustles with activity. G. Miller. *Oil Gas J.*, 17.8.59, **57** (34), 245.—There is active exploration and development drilling in the Simonette River region in W Alberta, 164 miles WNW of Edmonton, where ten wells have been completed. Oil has been found in the Devonian D_3, and the field promises to be one of the most promising D_3 producers in Canada. C. A. F.

1734. Development of France's Aquitaine Basin. J. A. Kornfeld. *Petrol. Engr*, April 1959, **31** (4), B40.—The Aquitaine Basin, in S France, accounted for 96% of the country's oil production in 1957. Development of the Lugos field, discovered late in 1956, adds to the importance of this rich basin. This field is currently producing in excess of 750 bd of 20·6° API crude from six wells. The Aquitaine Basin fields produced more than 10 million brl in 1957.

The surface geology, reservoir characteristics, and drilling practices in these fields are described in the paper. M. F. M.

TRANSPORT AND STORAGE

1735. The world tanker fleet. Anon. *Petrol. Times*, 11.9.59, **63**, 568.—The position as at 30 June 1959 has been reviewed by John J. Jacobs & Co and shows a record for new tonnage, this being 118 vessels of 3,631,615 tons deadweight. Estimated tonnage under construction is 599 vessels totalling 22,115,800 dw tons.

There is an increase in tankers exceeding 70,000 tons dw, and of particular interest is an additional berth at Finnart to take largest tankers afloat.

No major propulsion developments are reported, but of 599 new buildings, 376 are to be turbine propelled and 223 diesel propelled.

Further outlook is even more depressing than for 1958; laid-up figure is 7¼ million tons dw, approximately 12·5% of commercial world fleet, thus some large oil companies are seriously over-tonned.

Tables show major flags of world tanker fleet at date of review, and estimated delivery of new tonnage. G. A. C.

1736. "Hoister" equipment for tanker offshore loading. Anon. *Engineer, Lond.*, 1959, **208**, 335–6.—Description (illustr, drawing) of prototype equipment installed at Kuwait whereby connecting hose is lifted from sea bed by structure containing buoyancy tanks blown by compressed air (from launch). Tanker must be moored so that its movement is restricted to 40-ft radius. Increase of 33% in loading rate; decrease of 66% in amount of flexible hose required; less hose maintenance. V. B.

1737. How world's first pushbutton gas pipeline system works. D. G. Emmel. *Petrol. Engr*, April 1959, **31** (4), D24.—This is an article of general interest, describing how from a control console in Nashville, Tennessee, one man controls and monitors five 14,000-hp automatic stations and over 840 miles of the natural gas pipeline system belonging to Columbia Gulf Transmission Co. M. F. M.

1738. Spheroids separate batches in products pipeline. 2. M. C. Barrett. *Oil Gas J.*, 22.6.59, **57** (26), 116.—The technique is discussed of launching spheroids into the pipeline to separate fluid products. Basically the apparatus is a 14-inch dia pipeline magazine holding ten spheroids, which on a given signal allows one spheroid at a time to be dropped into an oversize tee in the carrier line, the product immediately washing it along.

Launching should be at intervals of not less than 120 linear ft, and by-passing pumping stations is provided for by a scheme which does not disturb the normal liq-flow pattern at the station nor require throttling back or stopping the pumps. Shell Oil Co intends to operate remotely the five intermediate pumping stations on the 14-inch Wood River–East Chicago line from a control centre in Indianapolis using the above scheme, and using a specially designed arrangement for preventing the spheroids entering side outlets of a pipeline. It is concluded that the proper use of multiple spheroids results in economics in pipeline operation, since the generation of mixtures is decreased and the spheroids are very satisfactory means of displacing or evacuating a fluid from a pipeline.

It is also more economical to operate than scraper dumbbells, and when controlled automatically labour costs will be reduced. G. A. C.

1739. Lakeland Pipeline installs new electrically powered pumping stations. E. B. Turner and W. D. Wiest. *Oil Gas J.*, 24.8.59, **57** (35), 66.—Latest concepts in unattended general type remotely controlled pipeline pumping stations include electrical pressure control system, thus eliminating maintenance of pneumatic system, automatic load control equipment to ensure continuity of operation, unitized electrical design to permit isolation of a unit without disturbing operation, grouping of all operational controls in one panel, an electrical protection system for station pressures, bearings, and vibration, and a digital telemetering supervisory system. Sequence circuits are shown. G. A. C.

1740. Low hydrogen electrodes and special joints for hot taps. R. S. Ryan and R. R. Wright. *Oil Gas J.*, 31.9.59, **57** (39), 171.—Basic factors associated with underbead cracking in-

clude entrapment of hydrogen in the weld deposit and the tendency to form a very hard brittle notch-sensitive martensite in the heat-affected zone caused by the heating cycle of the weld deposit. Fillet welds are also susceptible to underbead cracking.

Columbia Gas Co has successfully developed a special joint design and uses low-hydrogen electrodes for all grades of API 5 XL pipeline, using the bead method of deposition, the wide weaving action not being recommended because porosity results. Cleaning was found to be very important, and high places on various weld beads should be removed. Chipped electrodes are discarded, and precautions must be taken to maintain low hydrogen content of electrodes. Diagrams of joint designs are given. G. A. C.

1741. New correlation for two-phase pipeline flow. J. A. Chavez. *Oil Gas J.*, 24.8.59, **57** (35), 100.—Two-phase flow of liq and gas occurs in many plants where heating and cooling of the fluids are required. Thus pressure drops have to be estimated with some degree of accuracy, and the correlation given relates the different variables which have apparent effect on the two-phase flow of fluids in pipelines.

Two charts are presented which assist in determining the pressure drops in horizontal pipes, using dimensionless parameters, and an illustrative example is given. The average deviation lies between 6 and −5%. G. A. C.

1742. New tool measures distance fast. M. E. Fuller. *Oil Gas J.*, 7.9.59, **57** (38), 106.—The instrument, the Tellurometer, consists of two major components both equipped with radio transmitter and receiver powered by 6-V battery. Each unit has a variable-frequency crystal; the master one has a 2½-inch dia oscilloscope and measures long distances with speed and accuracy. Fog, haze, or darkness do not effect the meter, and no more time is needed for long lines than for short ones, but the instrument has limited usefulness on lines shorter than 500 ft. G. A. C.

1743. How Mediterranean can be crossed. R. Venet. *Petrol. Engr*, July 1959, **31** (7), D3.—The possibility of building direct pipelines from the new Sahara oilfields to Europe is under consideration. Four possible routes exist, two by way of Italy and two through Spain. The sea crossings for the latter two are being investigated. Two methods of laying the pipes in the sea-crossings are being considered: (1) welding on land, and towing the pipe along the sea bed; (2) coupling prefabricated sections on pontoons at sea. The arguments for and against these methods are given. Methods of combating corrosion are also considered. G. D. F.

1744. Pipeline fundamentals. Pt 1. Scheduling and dispatching crude oil and refined products. F. Ashford, Jr. *Petrol. Engr*, July 1959, **31** (7), D32.—The advantages and disadvantages of centralized and decentralized scheduling and dispatching organizations are considered. The functions of an oil-movement group are outlined, followed by a section on the scheduling and dispatching of crude oil. G. D. F.

1745. Russia revises pipeline goals. C. L. Adams. *Petrol. Engr*, June 1959, **31** (6), D34.—Under the present Seven-Year Plan, the 1965 target for the Soviet petroleum industry is 240 million metric tons of crude and 150 billion cu ft of gas. Pipeline bottlenecks exist at present production, so a revised pipeline programme is indicated. Plans are reported to pipe oil to the satellite countries, and Finland and Sweden, and to pipe crude to W Russian refineries, whence exports to the world are possible via the Baltic. Details of Russian pipeline construction since 1950, and of proposed lines, are given. Biggest project will be the 2300-mile, 28-inch line between the Ural and Lake Baikal regions, whence export to China is feasible. A large increase in Soviet pipe production is expected, but imports may be necessary. Non-metallic pipes are being considered. Pumping-station and pipe-laying equipment are also causing concern. G. D. F.

1746. Graphic method speeds line sizing. K. S. McMahon and J. C. Webb. *Petrol. Engr*, June 1959, **31** (6), C10.—A large chart is reproduced giving the pressure drops in pipelines between 1 inch and 12 inches dia, for Reynolds No. between 4000 and 3,000,000 (turbulent flow). Tables give the recommended pressure drops for pipes, Hazen-Williams coeff, and the equivalent lengths of a large range of pipe fittings. Other charts give the equivalent dia of non-cyl pipes and the flow characteristics of hand valves. Several worked examples of tricky flow problems are given. G. D. F.

1747. An underground storage pool takes form. Anon. *Petrol. Engr*, May 1959, **31** (5), D48.—A very large underground storage cavern, known as Todhunter Terminal, is being constructed in hard grey shale for Texas Eastern Transmission Corpn a few miles S of Middletown, Ohio. When it is placed in service next autumn it will have a capacity of some 18,900,000 gal. The storage will be used to receive, store, and distribute LPG over a wide area from Michigan to New England. The paper describes, with the aid of a number of photographs, the various stages in the construction of this large man-made reservoir. M. F. M.

REFINERY OPERATIONS

REFINERIES AND AUXILIARY REFINERY PLANT

1748. Short cut to pump selection for least power consumption. M. G. Jordan. *Oil Gas J.*, 21.9.59, **57** (39), 140.—A hydraulic nomograph is provided for selecting pumping units to fit hydraulic conditions resulting from varying terminal demands along a products line, and two colour illustrations show step-by-step use. The basic theory used in the development of the nomograph is given, and depends on a flow-rate nomograph to determine hydraulic gradient slope for a given flow rate, a focal point being connected with selected flow rate when pumping through a 24-inch line, friction loss in feet being represented by vertical scale on pump characteristics curve. G. A. C.

1749. Why do reciprocating compressors act as they do? C. S. Kenworthy. *Oil Gas J.*, 21.9.59, **57** (39), 201.—Questions concerning behaviour of reciprocating compressors are answered after a logical step-by-step development of the various concepts encountered in the compression cycle and include reason for h-p requirement increasing to a max and then decreasing as suction pressure is progressively lowered, and why lowering line pressure below design results in lowering efficiency. G. A. C.

1750. The disposal of oil refinery liquid effluents. S. A. Berridge and M. B. Shirley. *Petrol. Times*, 25.9.59, **63** (1621), 593.—The bulk of effluent to be treated consists mainly of cooling water drawn from the sea and used to remove heat from hot oil, hydrocarbon vapours, and steam condensers, and some comes from water washing of products, steam condensate, boiler blowdown, and surface drainage.

From a table giving thickness of oil films, appearance, and quantity of oil required to produce them, together with observations of oil films at sea, it is concluded that refinery

wastes would not cause polution provided the oil separator facilities yielded an effluent containing no more than 50 ppm and thin films were formed.

Equipment at the Esso refinery at Fawley is described and includes four separate sewer systems each handling specified waste. The clean water system takes all uncontaminated process water, the dirty water equipment handles water which has been in contact with hydrocarbons, the by-pass sewer takes water not contaminated with oil, and the sanitary system takes sewage to the sanitary treating plant. The first two systems discharge independently to separators, thence to a mixing sump, where it is joined by the by-pass sewer, and then through a 3200-ft effluent line, where it is aerated to provide oxygen required for decomposition of organic matters by aerobic bacterial action on the way to the sea. Water load is over 100,000 U.S. gal/min.

Spent chemicals, hydrogen sulphide, contaminated steam condensate, and spent caustic are rendered innocuous by carbonation, then steam stripping in a deodorizer, the liberated sulphur cpd being burnt in boiler furnaces. Control of the deodorizer was not possible by analytical test methods, so smell detection by operators is satisfactorily used.

Modification to oil separators due to particle size turbulence caused by post baffles, which latter have now been removed, and reduction of high rate of flight scraper maintenance by removing sections of chain belt are described. Corrosion problems in deodorizers have been met by lining with cement fondu. G. A. C.

1751. Modern gasoline plants. Pt 10. Design, operating, and purchasing aids. D. Vondy. *Petrol. Engr*, May 1959, **31** (5), C58.—A number of graphs are presented by the author to aid with the design of a gasoline plant. These include a plot of equilibrium constants (K) *v.* bp for hydrocarbons from C_1 to C_3, the absorber capacity in MMSCFD against the column dia for different operating pressures, and graphs for estimation of the optimum economic pipe dia. A general check list is then given as an operating aid, and the article is concluded by discussion of the prime consideration in purchasing. M. F. M.

1752. Hydroskimming—a new type of refinery. (In German.) Anon. *Chem. Ind.*, 1959, **11**, 264–5.—The new "Esso" refinery at Cologne was opened on 15 May 1959—a description of the refinery flowsheet is given. It has a capacity of 3·5 million tons of crude pa; 25% of the invested capital is for petrochemical production. P. J. K.

1753. Centrifuges pass tests as separators. M. J. Sergesketter. *Oil Gas J.*, 7.9.59, **57** (37), 162.—Shell Oil Co's studies in lab and field to determine practicability of electrically-driven centrifuges to remove water from crude oil in cases where gas is expensive, not available, or where a serious fire hazard exists shows separation to less than 0·5% in oil, chemical needed less than with conventional heating and settling process, and process is economically cheaper. G. A. C.

1754. Russian refining emphasis is on growth. Anon. *Petrol. Engr*, June 1959, **31** (6), C64.—The Soviet refining industry is being strained by the rapid increase in crude oil production. Products are often of poor quality: an increase in quality has been promised, but, with the large increase in output required, this will be difficult to achieve. A summary is given of Russian oil exports in 1957, and of production plans until 1965. The locations of recent and projected refineries are also given. Insufficient automation and the poor layout of many refineries keep the manpower requirements and cost of operation high, but steps are being taken to correct these shortcomings. Larger refineries of increased efficiency are planned. At present, more than half of the crude oil originates in the "Second Baku" fields, and is of high sulphur, paraffin, and salt content. Refineries to handle such crude have high capital and operating costs. A survey of Soviet production figures shows that motor fuel is unimportant, while tractor kerosine, jet fuel, and diesel fuels are in great demand. G. D. F.

1755. Gas turbine in steam power cycle. J. E. Parker. *Oil Gas J.*, 31.8.59, **57** (36), 77.—Problems which faced Union Carbide Chemicals Co at Texas City in the application of a gas turbine are discussed. Primary application is as driver for centrifugal air compressor. Exhaust steam from the turbine, which in reality is highly heated air, is fired under a boiler with enough fuel to utilize available oxygen in the exhaust. Overall efficiency of combined gas-turbine boiler is *ca* 77%. Diagrams show flow, effect of back pressure, ambient temp, altitude, and estimated characteristics of 7000 hp single-shaft and two-shaft gas turbine. G. A. C.

1756. Atlantic's new $10,000,000 wax plant. J. R. Ghublikian *et al.* *Oil Gas J.*, 31.8.59, **57** (36), 83.—One of the largest paraffin wax manufacturing plants in the world has recently come into operation at Philadelphia. Owned by Atlantic Refining Co, it has a 250-ton/day capacity and uses the Texaco solvent dewaxing process to produce close-cut, high quality, low oil content waxes having good hardness characteristics and high blocking temp.

The three filtering stages of the new unit are dewaxing, repulping, and wax fractionation. The first stage dewaxed oil product is stripped of solvent content and provides paraffin oils; the repulp wax mixed with a low oil content slack wax is reheated without stripping and chilled to *ca* 60° F for charging to the wax fractionation filters; there the higher-mp hard waxes are recovered as filter-cake; whilst the lower-mp waxes with practically all of oil from repulp wax mix appear in filtrate. The stripped cake is acid-treated and clay-percolated to give the fully refined product—semi-refined waxes are obtained by sweating to crude scale wax and acid and clay treating.

The new unit incorporates several innovations, such as additional segregation of moist and dry solvents, control of oil contamination in selected lower boiling waxy dist by fractionation using several bubble trays under solvent reflux, use of a controlled heating and chilling step between filtrations, and employment of H_2S removal system utilizing caustic soda to provide inert blanket gas from refinery gas. A separate hard-wax solvent recovery system is provided, the filter units are of special design, and the double-pipe-exchanger stands are equipped with removable inner tubes. Fourteen 11-ft × 20¼-ft, 700 sq ft conventional rotary filters are provided, and three separate solvent recovery systems are used.

A flow diagram and control system are shown. G. A. C.

1757. The Whitegate refinery. Anon. *Petrol. Times*, 28.8.59, **63** (1619), 520.—A general description is given of the new £12 million refinery of the Irish Refining Co situated near the entrance of Cork Harbour. Joint holders are Shell-Mex and B.P. (40%), Esso (40%), and Caltex (20%).

Crude will be imported from the Middle East at a cost of £12 million pa, and output will be 2 million tons pa, products being gasoline, tractor and turbo-jet fuels, derv, gas oil, and light, medium, and heavy fuel oils.

Refinery design is based on a crude dist capacity of 39,600 bd of Middle East crude, and units include an atmospheric crude topping plant, a cat reforming unit for octane upgrading of origin/naphtha, a copper sweetening unit, and a middle dist cat desulphurization unit.

Air-fin coolers for air-cooling product streams are a feature in the design; reinforced concrete construction is used rather than structural steel, and waste gases are burnt in a low elevation multi-jet smokeless flare burner.

Four Hortonspheres are included in tankage; the steam

plant consists of three package-type boilers with ion-exchange water treatment facilities. All process units are controlled from one control room centrally heated. G. A. C.

DISTILLATION

1758. Distillation—in view of modern developments. Pt 1. Phase equilibria and thermodynamic concepts. K. F. Gordon and J. A. Davies. *Petrol. Engr*, May 1959, **31** (5), C53.—The phase rule, the critical phenomena, and the common methods of presentation of the equilibrium data for binary mixtures are discussed in this article. Diagrams provided show various plots such as temp *v.* composition, and pressure *v.* temp for ideal, non-ideal, and azeotropic mixtures. M. F. M.

SOLVENT EXTRACTION AND DEWAXING

1759. Making high-quality asphalt with a propane deasphalting unit. L. R. Reinkeyer. *Oil Gas J.*, 7.9.59, **57** (37), 166.—Anderson-Prichard constructed a conventional three-tower crude-dist unit of 25,000 bd capacity, and after certain improvements in vacuum-tower operation a 3000 bd propane deasphalting unit was installed, at a cost of $230/brl of charge. As heavy wax is removed by the process the asphalt yielded is of high ductility and solubility over the wide range of penetrations. Charge to cat cracker is also improved, and 250 bd of No. 6 fuel oil is eliminated.

Tables show stream analysis, physical properties, and direct operating costs for 1958, and a flow diagram is given. G. A. C.

CRACKING

1760. Investigation of hydrocarbon conversion in a catalytic reforming installation. (In German.) H. Weller and W. Duve. *Erdöl u. Kohle*, 1958, **11**, 450–4.—On the basis of the analyses of gasolines from German crude oils conclusions are drawn on the conversion undergone in a reforming installation over Pt cat. The reaction mechanism of the catalysis over Pt is reported as far as possible. Three gasolines were investigated: the charged material, products reformed under mild conditions, and under sharper conditions. The gasolines were separated by fine fractionation and the fractions separated by a modified PONA method into paraffins, olefins, naphthenes, and aromatics. The chem composition of the gasolines is determined by analysis. Thus the distribution of the hydrocarbon groups according to the number of C-atoms in the mol is possible. Comparing the gasoline complete analysis including gas products, the hydrocarbon conversion is determined in so far as it is expressed by change between hydrocarbon groups, or according to the C–No in the mol within the hydrocarbon groups. A paraffinic–naphthenic gasoline of bad knock behaviour is changed to an *iso*paraffinic aromatic gasoline of higher knock resistance. Individual reactions prove dehydrogenation of naphthenes to aromatics, hydrocracking of paraffins, and, in two stages, dehydrocyclization of paraffins over naphthenes to aromatics. These reactions, chiefly isomerization, can change. In the case described aromatization is to be given preference. R. T.

1761. World's smallest Orthoflow cracker. W. Fisher, A. Mosic, and E. Knezevic. *Petrol. Refin.*, June 1959, **38** (6), 235.—An Orthoflow cracker, with a fresh feed charge capacity of 1960 bd, is being used for commercial production in Yugoslavia. The paper is a report on how well the plant is operating and what problems have been encountered in its operation. M. F. M.

1762. The third olefin plant at Wilton. Anon. *Petrol. Times*, 25.9.59, **63** (1621), 600.—A description is given of the administration and operation of the ICI Wilton plant, where the Kellogg steam cracking process is used to produce olefin from cracking of light dist. This third plant differs from the two previous units in positioning of overhead condensers, use of a compressive system in place of original absorption system for first stage refrigeration, and use of free piston engines in the centrifugal gas compressors. A flow sheet of No. 3 plant is given. G. A. C.

HYDROGENATION

1763. Influence of the structure of a silicotungstic acid on silica gel catalyst on catalytic activity. J. M. Oelderik and H. J. Waterman. *Chem. Engng Sci.*, 1959, **11**, 24–34.—An experimental investigation on the influence of a number of variables in the preparation of silicotungstic acid cat is reported. This cat is active in many reactions, such as the hydration and polymerization of propene and ethene. Cat activity increased with decrease of particle size. The effect of the percentage of silicotungstic acid used is also reported. It is suggested that a suspended cat (slurry process) might give the best results. G. D. F.

ISOMERIZATION

1764. Octane improvement at 5–10 cents per octane-barrel. K. P. Lanneau *et al.* *Oil Gas J.*, 10.8.59, **57** (33), 90.—An isomerization process for upgrading C_5/C_6 virgin naphthas being developed by Esso employs a highly active cat permitting liq phase operation at temp 80°–120° F, which temp level favours formation of the branched high-octane isomers, after the combined C_5/C_6 naphtha feed has been pretreated to remove impurities.

Unit costs for octane improvement depend on plant size and feed quality, and the low cost for motor gasoline octane improvement is very attractive. Typical feed and product data from pilot-plant operations isomerizing virgin Louisiana and Arabian C_5/C_6 feeds are tabulated, together with economics for the process. G. A. C.

1765. Get more isomer at low temperature. K. P. Lanneau *et al.* *Petrol. Refin.*, June 1959, **38** (6), 199.—This paper, originally presented before the Fifth World Petroleum Congress, describes Esso's new low temp isomerization process, which takes advantage of better equilibrium conditions. The importance of reaction temp is emphasized, and pilot-plant results presented show that higher isomerization temp give less desirable equilibrium compositions of C_5 and C_6 paraffins. Process economics are also discussed. M. F. M.

1766. A new isomerization process. K. P. Lanneau *et al.* *Petrol. Engr*, July 1959, **31** (7), C26.—A new low temp isomerization process is described for the improvement of the octane rating of virgin C_5/C_6 naphthas. The process operates at high once-through conversions, at temp of 80°–120° F, making recycling unnecessary. The cat used is active and selective, so that cracking and disproportionation are minimized. Data are given on pilot-plant operation, on the new process, and on the suitability of the product as motor fuel. Estimates of the process economics are given. G. D. F.

CHEMICAL AND PHYSICAL REFINING

1767. Catalytic desulphurization of cat cracker charge stock. H. T. Connally. *Oil Gas J.*, 14.9.59, **57** (38), 88.—A dist hydrodesulphurizing unit has been installed at Wynnewood, Ohio, for Kerr-McGee Oil Industries. A mixture of vacuum and atmospheric gas oil is fed to the unit, the process is flexible to give product improvement, and removes metals,

nitrogen, and sulphur, increases naphtha yield, decreases coke at constant conversion, and product octane is increased.

Tables show hydrogenation reactions, typical analyses, product yields, and operating costs. G. A. C.

1768. How first electrostatic desulphurizer has performed for Cities Service. K. O. Youngblut. *Oil Gas J.*, 24.8.59, **57** (35), 78.—The installation began operating at East Chicago, Oct 1958, and desulphurizes cat reformer feedstock with sulphuric acid; alkylation acid is used as the primary treating agent. Efficiency of sulphur removal is in range 80–95%, trace metal contaminants have been significantly reduced, and the process is economically competitive with other methods. Cost of unit was $350,000.

In the electrostatic desulphurization process electrical energy is used to impart a rapid, random motion to the dispersed acid particles which enhances completion of the reactions and increases degree of phase separation, the latter by utilizing electrostatic precipitation.

A flow chart is shown, and tables give typical charge product and operating data. G. A. C.

SPECIAL PROCESSES

1769. Cyclic adsorptive refining: Hungarian process. Anon. *Petroleum, Lond.*, 1959, **22**, 283.—This article describes the process carried out in Hungary for the production of white oils and aromatic-free naphthas by the use of cyclic chromatography and using silica gel as an ad-solvent. The principal advantage of the white oil process is in being able to dispense with sulphuric acid treatment and in the greater efficiency. In the production of aromatic-free naphthas by cyclic adsorption, the equipment needed is much simpler, as solvent refining treating and subsequent dist is no longer required. Details of the operating conditions, materials required, yields, etc., are included in the paper. M. F. M.

1770. Molecular sieves—the new refinery tool. P. W. Sherwood. *Petroleum, Lond.*, 1959, **22**, 245.—Molecular sieves, which were introduced in 1954, are finding industrial use in a number of refining and petrochemical operations. Examples are the drying of gases and liq, removal of hydrogen sulphide and lower mercaptans from hydrogen and natural gas, and for reducing the CO_2 content of an ethylene stream below 1 ppm. The properties which are reported to be characteristic of mol sieves in the separation of chemical cpds are: (1) they absorb small molecules but not large ones and can be used to make separations based on mol size differences; (2) they have a high adsorption capacity at low adsorbate concn; (3) they have an unusually high affinity for unsaturated organic materials and polar molecules; (4) they are capable of removing moisture from gases even at fairly high temp, at which other absorbents can no longer function as desiccants.

Unit cost of mol sieves is relatively high (*ca* $1·5/lb compared with a typical price of 35 cents for activated alumina). The active life of mol sieves may be shortened by the presence of certain unsaturated cpds. Mol sieves have also found many analytical uses which are described in the paper. M. F. M.

1771. Gas separation in gasoline processing: Russian methods. P. A. Smirnov. *Petroleum, Lond.*, 1959, **22**, 223.—This article is devoted to distinguishing the differences and similarities between various types of gas separation plants in the U.S.S.R. and explaining the most important features of each type. Three types of plants are described: (1) those preparing gaseous products for separation; (2) removal of methane–ethane fractions; and (3) the separation with absorption. Simple flow sheets are provided, but the paper is altogether too brief to be of very great value. M. F. M.

1772. Reforming with RD-150 platinum catalyst. W. H. Decker and R. Rylander. *Petroleum, Lond.*, 1959, **22**, 165.—The cat reforming unit at Sinclair's Houston refinery, with a design capacity of 24,000 bd, ranks as one of the world's largest units. This unit was initially placed on stream in early 1956 and has processed a total of over 20 million brl of naphtha. Of this total 17 million brl were processed by the unit during a continuous 26 months operation before the first cat regeneration.

The reforming cat used is the RD-150 and has the following characteristics: (1) high paraffin dehydrocyclization activity; (2) low hydrocracking activity; (3) excellent resistance to permanent poisoning effect of sulphur, metals, or water in the virgin naphthas; (4) needs no promoters for maintenance of its activity; (5) gives a constant yield structure; (6) it can be easily regenerated *in situ*, so that high activities may be maintained during the life of the cat.

The processing system at Houston plant and the performance of the cat are described in detail. M. F. M.

1773. Recent developments in the Oxo process. P. W. Sherwood. *Petroleum, Lond.*, 1959, **22**, 169.—The Oxo reaction for production of straight-chain aldehydes and alcohols is one of the novel methods of synthesis which has been directly adopted in the petrochemical field. The method, which effects the reaction of olefins with carbon monoxide and hydrogen, was originally developed in Germany and a commercial Oxo unit was operated by Ruhrchemie AG during the early 1940s. Since the war the Oxo process has found extensive application in a number of countries. Today there are five U.S. companies using the process and their combined total capacity is 165 million pa.

Lower Oxo derivatives include alcohols and aldehydes in the C_4–C_5 range. Here, production by the Oxo process takes second place to the conventional manufacturing methods. The bulk of Oxo facilities are utilized for the production of higher alcohols (*i.e.* C_8–C_{10}) a field in which the process offers unique advantages. Of chief importance is *iso*-octyl alcohol. Around 85% of the demand for C_8 and C_{10} alcohols is in the manufacture of plasticizers for PVC resins. Most important of these products are the derivative phthalate esters, with adipates and sebacates in the second position.

The technology of Oxo process is described in the paper, and a flowsheet of a version of the Oxo process is also included. M. F. M.

1774. New processes for oil residue utilization. (In German.) P. W. Sherwood. *Erdöl u. Kohle*, 1958, **11**, 379–83, 455–9. Pt I. Market development, solvent treatment, treatment with boron trifluoride, cat cracking. Pt II. Hydrogenating conversion, reform gases, and petrochemicals from residues.—Pt I. The effect of the low price of residual fuel oil on refinery operations is discussed. Total residual fuel oil production in the U.S.A. shows a gradual decrease since 1930, whilst gasoline, gas oil, and dist fuel oil production has increased. A consumption analysis in the main sectors, railways, navigation, etc., is presented. Change in product distribution arises from modern processes designed to bring about deeper final cracking whereby residues are converted into petroleum coke and light dist. Methods for decreasing residual oils are discussed under solvent treatment, special cracking processes, *e.g.* visbreaking and the newer Houdresid process, also cracking of topped crude oils with BF_3 cat, with reference to operational factors, temp, pressure, etc., and quality and quantity of gasoline yields. Pt II. By hydrogenating cracking the H/C ratio of the heavy products can be kept so high that the high-bp fractions can be used as raw materials for further cracking, with or without H_2 addition. In large-scale high-pressure hydrogenation gasoline yields of 93% are obtainable. High-pressure hydrogenation installations using pressures up to 700 atm are very expensive; the

max gasoline yield does not justify the cost. The trend is directed to use of less sharp hydrocracking processes which are used increasingly to convert inferior fuels, *e.g.* residual oils, into valuable products. In cracking residues through hydrogenation better yields of desired products are obtained than by gas oil conversion. H_2 desulphurization of topped crude oils under mild conditions, using Co–MoO_3—on Al_2O_3 cat, reduced the S cont of a W Texas crude oil from 2·4 to 0·6%. The mol wt, which can be taken from the fall of d_{15}, shows a slight fall from 0·937 to 0·918. Whilst the Gulf-HDS process aims especially at hydrocracking of residual oils, by a newly-developed process the bitumen therefrom is hydrogenated. The material charged being fractions from C_3H_8 or C_4H_{10} deasphalting of vac residues. Production of reform gases and petrochemicals, particularly C_2H_4 from residual oils, is discussed. R. T.

1775. New petrochemical process upgrades refinery tail gases. C. G. Gerald, G. L. Hervert, and C. B. Linn. *Petrol. Engr*, April 1959, **31** (4), C6.—A new petrochemical process for the economic manufacture of alkylated aromatics of very high purity has been developed by the Universal Oil Products Co and is called the Alkar process. Principal products are ethylbenzene and cumene from a feed of low olefin content gas streams. The process uses an entirely new fixed-bed cat system and employs moderate operating conditions which involve no corrosion problems. High sensitivity mass spectrometer analysis has demonstrated that the Alkar products are of very high purity. Yields are very high (pilot-plant operations have given yields of ethyl benzene of 100%). The conversion of ethylene and higher olefins is complete in the process. The main reactions of Alkar process are of olefins with benzene to form monoalkylated aromatics.

Flowsheets for the reaction and fractionation sections of the Alkar process, detailed description, and a discussion of the Alkar economics are given in the paper. M. F. M.

1776. More data on manganese anti-knock. H. J. Gibson, W. B. Ligett, and T. W. Warren. *Petrol. Refin.*, June 1959, **38** (6), 194.—A new anti-knock cpd, a methyl derivative of *cyclo*pentadienyl manganese tricarbonyl (MD-CMT), which can be used economically to improve the octane rating of some gasoline blends, is described in this paper. The new additive is a light, amber, mobile liq with a density of 1·39 and a manganese content of 24·7%. It has a fp of 34·6° F and a bp of 451° F. It is insoluble in water but miscible with organic liq at room temp. The ability of MD-CMT to increase the ON of a commercial fuel can be correlated roughly with the TEL susceptibility of the fuel. Natural gasolines have excellent response to MD-CMT, and it is claimed that blending of gasolines will be more flexible in a two-anti-knock system. M. F. M.

1777. New unit gives 110 F-1 ON alkylate. E. K. Jones. *Petrol. Refin.*, July 1959, **38** (7), 157.—The paper is a description of the HF alkylation unit of Leonare Refineries in Alma (Michigan) which incorporates the latest design factors. This unit was designed for the production of 1000 bd of motor alkylate at the cost of $850,000. A flow diagram of the unit is given, together with data on typical alkylate composition, blending characteristics, and other properties. M. F. M.

1778. A look at ethylene glycol today. P. W. Sherwood. *Oil Gas J.*, 24.8.59, **57** (35), 85.—A review is given of growth experience and markets of ethylene glycol, of which 1·2 billion lb was produced in the U.S.A. in 1958. Acid catalysed hydration and non-cat hydration techniques of manufacture are dealt with, and development of liq-phase processes, and work on vapour-phase techniques are described. G. A. C.

1779. The Texaco selective finishing process. W. F. Franz *et al.* *Petrol. Refin.*, April 1959, **38** (4), 125.—Selective finishing will upgrade the ON of such diversified stocks as cat reformate, light straight-run naphtha, or heavy FCC naphtha. Texaco Selective Finishing may be used to treat a cat reformate either to produce a higher ON product or to reduce the reformer severity required to produce a given ON product, with the consequent increase in cat life.

The essential part of the Texaco process is the solid adsorbent used; a five Angstrom unit selective adsorbent. It is a synthetic zeolite material whose unit cell has the form of a modified cube. In the particular version of the process described in the paper the operation is cyclic, using fixed beds of selective adsorbent. The conclusions reached by the authors are that: (1) the Texaco process is effective in improving the ON of full boiling range or light cat reformates, light straight naphthas, and isomerate stocks; (2) efficient separation is possible; (3) processing costs, when calculated for application of this process to a hexane isomerate stream, appear reasonable. M. F. M.

1780. The Molex process. D. B. Casson and D. B. Broughton. *Petrol. Refin.*, April 1959, **38** (4), 130.—The Molex process of UOP provides means of removal of low quality normal paraffin components from gasoline. The process uses an adsorbent in a fixed-bed isothermal manner, and feed and separated product streams are uniform and continuous. Temp and pressures are moderate, and ordinary materials of construction are satisfactory. Pilot-plant results for three different mixtures of C_5 and C_6 hydrocarbons are given in the paper. These stocks were, first, a mixture of C_6 paraffins; secondly, a mixture of C_5 and C_6 paraffins, and, thirdly, a light extract cut of Rexformate which has olefins and aromatics as well as paraffins. The process has been shown to be economic, not only in comparison with fractionation, but also when called on to perform separations not practicable with fractionation. M. F. M.

1781. Giammarco–Vetrocoke processes. F. C. Reisenfeld and J. F. Mullowney. *Petrol. Refin.*, May 1959, **38** (5), 161.—For acid gas removal the new processes from Italy, Giammarco–Vetrocoke, show distinct advantages over conventional methods. There are two distinct processes, one for the removal of CO_2 from gases essentially free of H_2S, and another for selective H_2S removal. These processes are based on the absorption of acid gases in an alkaline soln containing inorganic or organic additives. Both the CO_2 and H_2S removal processes have been applied commercially in a considerable number of installations in Europe and have recently been made available in the U.S.A. Gases treated in European installations are primarily coke-oven and synthetic gases, but extensive pilot-plant studies have also been made with hydrocarbon gases. The process is suitable for treatment of any industrial gas stream.

The Giammarco–Vetrocoke CO_2 removal process utilizes hot aq alkali carbonate soln which are activated by either small amounts of organic substances or by substantial amounts of inorganic materials. The H_2S removal process is based on the absorption of hydrogen sulphide in soln containing a mixture of alkaline arsenites and arsenates. Considerable flexibility, such as selective H_2S absorption, or simultaneous absorption of both H_2S and CO_2, can be obtained by proper selection of reactants.

The two processes are described in detail with the aid of process flow sheets, and technical and economic comparisons are made with other commercial processes in use. This is a very good paper containing much useful data. M. F. M.

1782. Process natural gas by permeation? C. J. Walters. *Petrol. Refin.*, May 1959, **38** (5), 147.—Permeation of a multicomponent gas mixture through a non-porous film is somewhat similar to absorption-stripping cycle. Components absorb on one side of the film, diffuse to the other side, and revaporize. Certain components go through the film at a faster

rate than others, and the driving force is the pressure difference. The permeation process is of interest because of its physical simplicity.

The paper sets out to show how effective permeation might be in separating light hydrocarbons. The cell used for the study is described. This is a set-up similar to a tube-in-shell heat exchanger. The tube bundle consisted of 36 polyethylene tubes 4 ft in length and 1·5 mm od (1·14 mm id). The shell was made from a length of 2-inch dia pipe.

The results of this study show that appreciable separation can be obtained by permeating mixtures of light hydrocarbons through polyethylene film. A multi-cell with recompression between the stages could be designed to give any desired degree of separation. The design calculations for such a system handling a multi-component mixture would require a digital computer. Until such calculations are made so that costs can be estimated, the economic attractiveness of the permeation process cannot be predicted. M. F. M.

METERING AND CONTROL

1783. Instrumentation in the petroleum industry. Pt 1. Accurate indication, recording, and control of temperature. R. Postle. *Petroleum, Lond.*, 1959, **22**, 212.—The petroleum industry handles very large volumes of liq on a continuous basis. To provide the necessary information and control of the properties of the liq being treated in various stages of a process, extensive and complex instrumentation is essential. In this article the advances in the instrumentation field to meet the requirement of the petroleum industry are described. Temp measurement and recording and temp control are discussed in detail. Pressure and flow controls will be treated in Pt 2. M. F. M.

1784. Getting top performance from turbine meters. A. J. Granberg. *Oil Gas J.*, 31.8.59, **57** (36), 61.—In order to obtain max performance from these new meters, velocity, visc, and temp conditions must be carefully analysed. *E.g.* the meter would provide a short measure if a film of oil on the blade added to its thickness, reducing amount of liq flowing through the meter per revolution of the rotor.

Low visc fluids, such as gasoline, have no practical effect on blade-film thickness, but a liq of 1000 S.U. visc would cause low readings if the velocity was relatively high, say 15 ft/sec through the instrument. Corrective measures include use of adjustable visc brake, and employment of three rotors to reduce number of blades for each rotor. Heavy oils should be maintained within controlled temp limits as determined by overall accuracy required. G. A. C.

1785. Modern gasoline plants. Pt 9. Gasoline plant instrumentation. D. Vondy. *Petrol. Engr*, April 1959, **31** (4), C33.—Instrumentation fundamentals and special instruments and control systems are discussed in this paper. Motor valves, relief devices, analytical pressure instruments, secondary controls, and instrument centralization are reviewed in some detail, and advice is given on the maintenance of instruments. M. F. M.

1786. Radioisotopes for interface detection. C. W. Blackburn. *Oil Gas J.*, 21.9.59, **57** (39), 227.—Phillips Petroleum Co use several types of interface detectors, including kind which measures change in dielectric constant of the product as interface between water and gasoline passes probe, producing a change in capacitance, causing an alarm to sound, or light to come on. To detect passage of LPG, an instrument of critical sensitivity to detect a spread of 1·6–2·1 dielectric constants is necessary.

Radioisotopes, which are unstable isotopes constantly disintegrating, can be detected in extremely small quantities, and are absorbed by the stream of fluids. Caesium-137 is used to detect change in density of a fluid, the change causing more or less radioactive energy to be absorbed and measured. For safety the source holder has lead-laminated brackets and a lead shield and a specially designed rotary shutter.

Another method of detection is to inject a radioactive tracer at one point in the pipeline and detect it at another.

Cost of radioisotopes and of precautions necessary in handling make their use somewhat expensive. G. A. C.

1787. Mass-flow measurement. Why? How? H. P. Bean. *Oil Gas J.*, 10.8.59, **57** (33), 87.—Three different methods of measuring weight of flowing gas have been field tested and proved accurate; they include mass-flow with orifice meter, vortex-velocity-type mass-flowmeter, and velocity-change mass-flowmeter. Thus mass measurement would eliminate need to define standard conditions and eliminate need to determine sp gr and supercompressibility.

The orifice meter type employs a density cell consisting of a hollow spinner rotating at constant speed, and difference between line pressure and pressure at spinner centre is directly proportional to specific weight of the gas.

The vortex-velocity type measures gas flow at flowing conditions, and weight of gas is determined from vol flow and specific weight, the latter being determined by a separate device.

Velocity-change mass flowmeter uses force required to produce a velocity change in a flowing fluid, and consists of two essentially identical thin-walled concentric cyl with annular space divided into narrow horizontal passages; the torque force produced is directly proportional to weight flow rate. One drawback is that all three types require a 110-v, 60-cycle power supply. G. A. C.

PRODUCTS

CHEMISTRY AND PHYSICS

1788. K's for aromatics. D. S. Hoffman and J. H. Weber. *Petrol. Refin.*, July 1959, **38** (7), 137.—This article presents vaporization equilibrium constants for toluene over the temp range 60°–460° F and pressure range of atmospheric to 300 psia. The data would be most useful in design of any unit for separation of aromatic hydrocarbons. M. F. M.

ANALYSIS AND TESTING

1789. Automatic analysis by fractional distillation. (In German.) F. Saltzer. *Chem. Ing. Tech.*, 1959, **31**, 405–8.—An apparatus is described which automatically carries out dist according to ASTM D86/54, D1078/49T, D158/54, or DIN 51–751. Details are given of results obtained for a number of materials using the standard manual method (ASTM D1078/49T) and with the automatic apparatus. P. J. K.

1790. A constant temperature corrosion probe. R. W. Kear. *J. Inst. Fuel*, June 1959, **32**, 267.—A simple corrosion probe capable of operating at constant temp for long periods with minimum service attention is described. Other methods of assessing flue gas corrosion are reviewed. Some results and a discussion to illustrate the scope of the instrument for use in full scale boiler and lab scale investigation are included. 15 refs. D. K.

1791. Field testing of transformer oils proves accurate. W. Lajousky. *Elec. World, N.Y.*, 1959, **151** (24), 50–1.—Details are given of field testing with transformer oils which compare favourably with lab tests. No lab technicians or specialists are required. P. J. K.

1792. Flash point detectors for quality control of pipeline products. J. P. Polston. *Oil Gas J.*, 7.9.59, **57** (37), 205.—Standard Oil Co of Indiana now employs five different types for testing heating oils, of particular use to determine cut points in mixtures of oils and gasolines in buffer between the 2-inch pipelines. One " go–no-go " device carries out the test on basic principles in 2½ minutes, flashing a green light for saleable heating oil and a red one for unmarketable material. Another type of instrument used is a continuous fl pt recorder. Three of the instruments are now marketed under licence. G. A. C.

ENGINE FUELS

1793. Modern gasoline plant design—three basic processes. 1. Absorption; 2. refrigeration; 3. adsorption. G. D. Johnston. *Petrol. Engr*, May 1959, **31** (5), C3.—This is a short article making a brief comparison of natural gasoline recovery processes. Flowsheets are provided for a conventional oil absorption type plant, low propane recovery refrigerated plant, and a hydrocarbon recovery adsorption unit. The merits of each system are briefly discussed. M. F. M.

GAS OIL AND FUEL OIL

1794. Britain's fuel and energy needs: the next ten to twenty years. A. Parker. *J. Inst. Fuel*, March 1959, **32**, 98.—It is concluded that the coal equivalent of indigenous coal, oil, and hydro-electricity produced each year in the U.K. will not change very much in total over the next 10–15 years. The demand for fuel and power will increase by the coal equivalent of 25 million tons by 1968–70. ⅔ of this will be provided by electricity from nuclear power and ⅓ by the use of an additional 6 million tons of petroleum oil. The use of raw coal will decline, but will be balanced by an increase in the quantity of electricity from coal-fired power stations. D. K.

1795. How to eliminate nozzle coking. Anon. *Fuel Oil & Oil Heat*, April 1959, **18** (4), 55.—Socony Mobil recommend the application of an insulating type of cement to burner parts surrounding the nozzle to reduce nozzle coking. The space between the brick combustion chamber and the burner blast should be filled by an insulating cement and also the face of the nose piece. Experiments were made using two mineral-type insulating cements, asbestos, and refractory cement. The latter two were not satisfactory.

Two procedures can be followed, and these are outlined. D. K.

1796. Mighty marvel oil burner. J. W. Schulz. *Fuel Oil & Oil Heat*, April 1959, **18** (4), 64.—A new kind of oil burner has been developed in a lab operated by the American Thermo-Catalytic Corpn. New types of house-heating furnace and boilers are also being designed.

The burner in operation is like a Welsbach mantle. The part that serves the oil burner as a flame plant is called a Pyrocore. The Pyrocore appears to be made of a porous refractory. It is tall, cyl, and operates in the vertical position. It is hollow; a hot mixture of air for combustion and No. 2 fuel oil heated enough to vaporize the oil completely flows into the hollow inside the Pyrocore. The combustion occurs in a matter of millisec, within the time the vaporized fuel oil and air takes to pass through the wall of the Pyrocore and leave its outside surface.

The outside surface glows with heat but is not surrounded by any kind of exterior flame. The surface temp of the Pyrocore is *ca* 1850° F and has a heat release of 20,000 Btu/in² of external surface, but higher rates are possible. The unit demonstrated at the lab is nominally rated for a fuel oil input rate that corresponds to 35,000 Btu/hr. D. K.

1797. Presidential Address. 1959—" Oil Burners—1859 to 1959." T. C. Bailey. *J. Inst. Fuel*, May 1959, **32**, 202.—The history of the development of oil burners is reviewed in Russia, the U.S.A., France, and Great Britain. Pressure jet, rotary, medium-pressure air burner, fully automatic burners, concentrated-combustion burner, self-proportioning are aspects particularly considered. D. K.

1798. The prevention of steel stack corrosion and smut emission with oil-fired boilers. H. A. Blum, B. Lees, and L. K. Rendle. *J. Inst. Fuel*, 1959, **32**, 165.—By surrounding the chimney with a bright aluminium sheath having a ¼-inch radial gap which reduces the heat loss by conduction while the bright aluminium surfaces reduce radiation, smut emission is prevented, and corrosion reduced to very small proportions. Five refs. D. K.

1799. Fuel problems in merchant ships. W. McClimont. *J. Inst. Fuel*, 1959, **32**, 225.—The nature of residual fuel oil, and the influence of shipboard storage practice, particularly with reference to sludge formation, are discussed. The main problems encountered in boilers are considered. Damage to brickwork is more a matter of spalling than of slag erosion. It is suggested that the significance of V in the problem of bonded ash deposits in conventional marine boilers may have been overrated. Air-heater corrosion and blocking are considered. Cyl wear and sticking piston rings are difficulties encountered using boiler fuel for large marine diesels. Gas turbines for marine use give rise to problems of ash fouling and corrosion. Some observations are included on the removal of sodium from the fuel by a water washing process incorporated in the fuel system. There are 14 refs and 9½ pp of discussion. D. K.

1800. The economic use of fuel oil in industry. G. F. J. Murray. *J. Inst. Fuel*, June 1959, **32**, 287.—The inherent physical advantages of fuel oil, *e.g.* cleanliness, flexibility of handling, and storage, are related to applications to which they are most suited. Typical applications showing economic advantages obtained which are considered include open hearth steel furnaces, ceramic kilns, and evaporation processes. High temp, high emissivity, and high heat availability of fuel oil flames are also discussed. Relative consumption figures for fuel oil and coal for industrial processes in the U.K. are given, as also are grades of fuel oil available. D. K.

1801. Reports on Performance Trial No. VIII of the Joint Committee of the International Flame Research Foundation on the experimental oil and gas furnace at Ijmuiden. (1) Comparison of different methods of fluid-atomizing oil flames. E. H. Hubbard. *J. Inst. Fuel*, July 1959, **32**, 328.—Experiments were made to compare the effects of different methods of fluid atomizing on oil flames. The main conclusion is that in a turbulent jet diffusion flame the burner reaction thrust is the principal variable; the means by which the thrust is obtained is less important. The total radiation from an air-atomized flame is the same as that from one atomized with steam, but it is more uniformly distributed over the flame length. The temp of an air-atomized flame is higher. Seven literature refs.

(2) The effect on flame emissivity and radiation of the addition of carbon black to liquid fuels. E. H. Hubbard. *ibid*, **32**, 338.—In these experiments a 50/50 suspension of

carbon black in fuel oil was added in turn to gas oil and a fuel oil. The effect on turbulent jet diffusion flames burning these mixtures was to increase the flame emissivity at a fixed distance from the burner, roughly in proportion to the increase in C : H ratio. The increase seemed more pronounced at the tail of the flame. As there are difficulties in keeping more than 6% C by wt in suspension in fuel oil for long periods, in industrial practice it is usual to inject the C as near to the burner as possible. D. K.

LUBRICANTS

1802. What Trunkline has learned about compressor-station lubrication. C. R. Carter. *Oil Gas J.*, 21.9.59, **57** (39), 184.—Conclusions on types of oil, oil filtration, centrifugal oil cleaning, synthetic lubricants, non-lubricated packing, and aluminium bearings are given, based on test results that have indicated improved operations.

Use of synthetic fire-resistant lubricants for air compressors reduces explosion hazard. Tests with non-lubricated packing (molybdenum disulphide impregnated) indicate suitability, provided problem of lamination can be overcome. Aluminium bearings were fitted to eight engines in 1952–53, and none have been changed since. Cleanliness of oil is a factor in all cases. G. A. C.

1803. Lubrication of large piston compressors. (In German.) G. Westhoff. *Chem. Ing. Tech.*, 1959, **31**, 516–18.—Only with low-pressure piston compressors is it possible to use the same lubricant for the cyl and for the gear drive. Normally, two quite different lubricants are required, and the desired properties of these lubricants are discussed, with particular reference to the nature of the gas being compressed. P. J. K.

1804. Determination of acidity in dark lubricating oils. W. Gibb and H. Gibson. *Petroleum, Lond.*, 1959, **22**, 257.—Acidity in lub oils is caused primarily by the reaction of oxygen with the oil at elevated temp. Considerable difficulties are encountered in measuring this acidity with any degree of accuracy. Of the current test methods used, colour indicator, potentiometric, and masked-fluorescent indicator methods are reviewed in the paper, together with recommendations based on the author's own researches. M. F. M.

BITUMEN, ASPHALT, AND TAR

1805. Many papers on bituminous paving problems. Anon. *Rds & Str.*, Sept 1959, **102** (9), 178.—Papers at the symposium on "Methods of Testing for Design of Bituminous Paving Mixtures" sponsored by ASTM Committee D-4 on Road and Paving Materials during the ASTM's 62nd annual meeting at Atlantic City are briefly noted. Papers included "General Factors in the Design of Bituminous Paving Mixtures," "Theory and Application of a Gyratory Testing Machine for Hot Mix Bituminous Pavement," "Control of Bituminous Shoulder Construction for Northern Illinois Toll Highway," "Correlation of Hveen Stabilometer and Cohesiometer Test Results and Kneading Compactors Densities with Service Records of Bituminous Pavements," and "Statistical Approach to Binder Tests." G. A. C.

SPECIAL HYDROCARBON PRODUCTS

1806. Investigations into the resistance of transformer oils to aging depending on their constitution. (In German.) R. Müller and T. Wörner. *Electrotech. Z*, 1959, **80 (A)**, 623–8.—During the last two decades transformers have been built to ever higher voltages and max performances. This has caused increased interest in the problem of the aging of transformer oils. The problem has been investigated with particular reference to the constitution of the hydrocarbon molecules, and an attempt has been made to correlate constitution, particularly aromatic content, with aging properties and the loss factor during aging. In general, the aromatic content, which has normally been reported as a statistical average, is not, by itself, a satisfactory measure of aging characteristics. P. J. K.

MISCELLANEOUS PRODUCTS

1807. New additive now gives high octanes at low cost. R. S. Aries. *Petrol. Refin.*, July 1959, **38** (7), 159.—A new additive, tertiary butyl acetate, is found to increase the anti-knock rating of motor fuels. One of the notable advantages of this new additive is its greater effectiveness at higher octane levels. Lab and road octane ratings are given in this report to show the amount of octane improvement achieved. The cost of the additive has not been established on a commercial basis. Tentative estimations indicate, however, that the additive will be a much cheaper approach to higher octane gasoline than additional refinery processing. M. F. M.

CORROSION

1808. Corrosion: holes in the oil industry's pocket. (The Atlantic Lectures of the University of Texas. Pt 7.) H. A. Stiff, Jr. *Petrol. Engr*, May 1959, **31** (5), B19.—The oil industry pays a staggering sum, *ca* $2 billion pa, in its fight against corrosion. The direct annual cost of corrosion in the U.S.A. for all industries has been estimated at $5·5 billion. Breaking the total figure into individual items shows that the cost of water treatment is (in $ billion) 0·3, pipes 0·6, maintenance and repair 1·2, paints and coating 2·1, and alloys and plating 1·3.

The article is interesting as a general guide to the cause and cost of corrosion with only very brief mention of the chemical corrosion inhibitors, cathodic protection, and other means of control of corrosion. M. F. M.

1809. Protection of large tanks against corrosion. (In German.) H. May. *Erdöl u. Kohle*, 1958, **11**, 403–4.—In the process described with supporting illustrations rolling scale is removed from the metal in a hot H_2SO_4 soln. The sheets are transferred to a water bath to remove adhering acid. Immersion in a hot dil H_3PO_4 soln follows, giving the surface a coating of iron phosphate. This coating delays corrosion and provides a binder for subsequent paint coatings. R. T.

1810. Cladded sheets for the petroleum industry. (In German.) M. Komers. *Erdöl u. Kohle*, 1958, **11**, 397–401.—Under modern operating conditions corrosion assumes extreme importance in the oil refinery from S cont of the crude oil or high-pressure H_2 in processing oil residues. Straight 4–6% Cr steel may meet some requirements, but complete corrosion resistance begins only at Cr cont 12%. To resist severe corrosion damage austenitic Cr–Ni-steels with or without Mo are often necessary. These materials are used seldom for constructing complete containers. On tech and economic grounds a cheaper basic material is used with a rustproof material cladding. In U.S. procedure a rustproof sheet is tacked to the base material by spot welding with 1-inch gaps. This is satisfactory if no strong temp fluctuations occur. The

strip-lining process—metal strips attached with fillet-welds—is generally an emergency measure. Applications of the processes are illustrated and American practice is compared with European. Details are given of the procedure adopted for welding a vac tower dia 7·5 m, ht 37·2 m, and wt 230 tons, exceeding the normal limits for rail dispatch. The different zones were cladded with 13% Cr steel or 18/8/2 alloys. The upper part consisted of boiler plate H II. Numerous illustrations of sections and of the completed tower whose dimensions permitted water transport only. For transporting the tower to the sea-going ship two 230-ton floating cranes were employed. The tower was lifted from the water at the refinery and cut into two parts for erection. Details are given for another vac tower for transportation overseas. Use of cladded sheets in refineries is expected to increase. R. T.

1811. Coal tar epoxy resin coatings. N. T. Shideler and F. C. Whittier. *Pipe Line News*, Sept 1959, **31** (9), Insert 8.—The coal tar epoxy resin coating system is a result of continuing research for many years for a cold applied pipeline coating. The first coating of this type was tested in 1952, and by 1953 it was recognized that this coating had unusual hardness and chemical resistance. It was first used as a tank bottom coating for crude oil storage tanks, but by 1955 the pipeline industry had become interested in this type of coating.

The chemical structure of epoxy resin and the reaction of the resin and the hardener cpd are discussed in the paper. Curing agents are mentioned, and the average composition of this type of epoxy coating is given as: epoxy resin 30%, coal tar 25%, solvent 20%, pigment 25%, and curing component one part by vol. Curing time for coal tar epoxy resins, their hardness, and other useful information are also included in the paper. M. F. M.

1812. Aluminizing resists refinery sulphidation and oxidation. G. F. Tisinai and C. H. Samans. *Petrol. Engr*, June 1959, **31** (6), C20.—Sulphidic corrosion in reformers, cokers, and pipe stills can be controlled by the use of aluminium coatings, which are much cheaper than using stainless steel for construction. The application of aluminium coatings by dipping, spraying, and spraying with heat-diffusion to various pieces of refinery equipment is dealt with, and the protection afforded by the different methods is compared. Methods of solving the problems of welding aluminized parts are also given. G. D. F.

1813. Processing crude oil at low pH. J. A. Biehl and E. A. Schnake. *Petrol. Engr*, June 1959, **31** (6), C29.—A table compares the corrosion rates of carbon steel and admiralty in crude oil overhead equipment under the following conditions: (1) pH kept at 6·8–7·5 by NH_3 injection only; (2) NH_3 injection to pH 6·8–7·5 + 6 ppm amine inhibitor; (3) small NH_3 injection to pH 4·0–4·5 + 9 – 12 ppm inhibitor. The last condition has been used for five years, and is found most satisfactory. The advantages claimed include: (*a*) decreased incidence of complex corrosion problems; (*b*) freedom from sludge deposits; (*c*) improved product quality; (*d*) process water is less polluted by H_2S. An electrical-resistance type of probe was used for monitoring corrosion. G. D. F.

1814. Reduce cooling system corrosion. C. T. Palen. *Petrol. Refin.*, May 1959, **38** (5), 239.—Improvements in corrosion inhibitors and pH control systems have led, in recent years, to the increased use of steel tubes for condensers and coolers in industrial cooling water systems. The paper shows that the precleaning of new steel condensers and coolers is essential if the max effectiveness of inhibitors is to be obtained. Fabrication oil films on steel tubes interfere with inhibitor adsorption, and it is also evident that, under no flow conditions, critical depletion of inhibitor in new tubes may occur within a few hours. It is therefore essential that flow, once started, should be maintained without interruption as long as possible. Minimum time required to establish an inhibitor film has not been determined, but it may require several days. The paper includes a number of interesting photos for comparison of rates of corrosion with or without pre-treatment. M. F. M.

ENGINES AND AUTOMOTIVE EQUIPMENT

1815. Combustion studies in a transpiration cooled gas-turbine combustion chamber. B. V. Poulston. *J. Inst. Fuel*, June 1959, **32**, 279.—A research combustion chamber using the principles of effusion cooling in the form of the "louvred" wall construction are described, together with the apparatus and techniques used for studying its performance. The chamber incorporates a swirler/shroud flame stabilizer and simplex pressure jet atomizers. The general combustion characteristics of this type of stabilizer are considered and the research results are discussed from the point of view of discovering the precise effect of the air which passes through the "louvred" walls. Four refs. D. K.

SAFETY PRECAUTIONS

1816. Use vibration analysis to pinpoint trouble. L. N. Dawson. *Petrol. Engr*, April 1959, **31** (4), C24.—Trouble-spotting on pumps, compressors, fans, blowers, electric motors, and many other items of refinery equipment can be simplified by using an electronic vibration analyser. The analyser consists of an inductive pickup which transforms mechanical vibrations into a corresponding electrical signal whose voltage is directly proportional to the amplitude of vibration. This signal is amplified in an electronic circuit and is registered in an amplitude meter and a frequency meter. The pickup is equipped with a probe to reach otherwise inaccessible parts of operating equipment.

The scope of the instrument is illustrated by citing some causes of malfunctioning: (1) a mechanical failure sets up a vibration frequency twice that of the speed of the rotating member concerned; (2) in equipment utilizing pressure lubrication systems, oil whip in sleeve bearings usually sets up a vibration equal to one-half of the rotational speed; (3) tooth interference between mating gears will set up a vibration in one gear equal to the product of the number of teeth in one gear and the gear rev/min. Many other instances are cited and the application of the analyser in pinpointing the trouble in low-speed equipment, compressors, etc., is also reviewed. M. F. M.

ECONOMICS AND MARKETING

1817. The sanctity of petroleum concession contracts. Anon. *Petrol. Times*, 28.8.59, **63**, 528.—A commentary is given on the paper presented by F. Hyndrex at the First Arab Petroleum Congress in April 1959, which caused some surprise if not alarm.

If Hyndrex is correct, then a government, after conclusion of an agreement with a contractor, would be free unilaterally to revoke that agreement. The commentator discusses this and other points, including Hyndrex's reliance on the 1921 decision in Rederiaktiebologet Amphitrite *v.* Rex (1921 3 K.B. 500), which reliance is regarded as unsound.

Reference is made to the very recent judicial examination of the principle of sanctity of concession contracts which took place in the arbitration in Geneva, 1956, between Saudi-Arabia and the Arabian American Oil Co, where respect for private acquired rights is repeatedly invoked as a basis for that sanctity. G. A. C.

1818. The Fourth International Hydrocarbon Convention. Anon. *Petrol. Times*, 25.9.59, **63**, 597.—Mattei's paper traced history of oil and natural gas transportation. Regarding transportation of liq methane in tankers, this was economic only if wellhead price of oilfield gas was very low. Similarly, the project for pipelining Saharan gas under the Mediterranean to Europe was not economic unless very large quantities could be transported so as to spread overheads.

The Genoa–Aigle pipeline and additions were dealt with in the paper, and in conclusion the recent achievements of ENI were enumerated.

A paper by Hirsch traced historical development of the Austrian natural gas industry and featured the Zwerndorf and Aderklaa fields, the latter discovered in April 1959 in a Mesozoic dolomite at 2850 m.

Natural gas fields in the Netherlands were described by Hofman. Half the Netherlands is covered by a natural gas distribution network to town gas, but consumption represents only 25% of total gas utilized.

Two films, "The Obstacle Race" and "Methane: the New Wealth," dealt with the Lacq gas.

Duquesne de la Vinelle's paper, "Hydrocarbons in the Framework of the Energy Economy of the European Community," dealt with the progressive multiplication of energy sources, and pointed out that greater accuracy in making of forecasts for energy requirements was necessary. G. A. C.

1819. A survey of effluent disposal. Anon. *Petrol. Times*, 25.9.59, **63**, 592.—This is a foreword to a series of three articles on the subject contributed by Esso, BP, and Shell at the request of the *Petroleum Times*, and they will show in some detail the steps taken by the oil industry to prove itself a good neighbour. Historical and legal aspects of the Alkali, etc., Works Regulation Act of 1906 and further orders are briefly dealt with. G. A. C.

1820. Oil law for the Belgian Congo and Ruanda Urundi. Anon. *Petrol. Times*, 25.9.59, **63**, 26.—A summary is given of the law enacted 31 March 1959 conceived in a very liberal spirit, regulating petroleum operations in the above area.

Points from the law include the right reserved to the Belgian Congo to subscribe to the initial capital of an operating company, but there are no requirements as to prior right to supply of oil or gas produced, nor as to training and employment of indigenous personnel.

There is no time limit on preliminary exploration, and exploitation right is for 50 years, renewable for a further 40.

A depletion allowance is comprised regarding taxation and royalties on exploitation.

An account is given of the projects financed from the Development Fund established by the Rome Treaty.

G. A. C.

1821. Petrochemicals plants—1959. Anon. *Oil Gas J.*, 7.9.59, **57** (37), 126.—A worldwide survey shows more than 150 projects planned or under way, with emphasis on new polyethylene and polypropylene plants. The survey is in six parts, organic, nitrogen–chemical, butadiene and copolymer, sulphur conversion, carbon black, and roller process plants, arranged alphabetically for the U.S.A. and grouped by countries other than the U.S.A. G. A. C.

1822. Europe's petrochemical growth. H. A. Kirsch and W. E. Kuhn. *Oil Gas J.*, 7.9.59, **57** (37), 123.—Production had grown in five major European countries from 208,000 metric tons in 1953 to *ca* 630,000 metric tons in 1958. Production is expected to be 2 million metric tons by end of 1960. Surplus should be available for world market. Tables show 1959 refining capacity and investments in petrochemical facilities. G. A. C.

1823. Which acetylene removal scheme is better? W. H. Stanton. *Petrol. Refin.*, May 1959, **38** (5), 177.—Two methods are in commercial use for the removal of acetylene from rich ethylene streams. One is absorption in a selective solvent (*i.e.* dimethyl formamide), and the other, cat hydrogenation of acetylene. Both methods are capable of removing acetylene from ethylene to meet the most stringent specifications.

After describing the above two processes, with the aid of flowsheets, an economic comparison is made based on flow rates and other variables. The main conclusions are: (1) hydrogenation is the preferred method when acetylene make is low, when acetylene has little value, or when the size of ethylene facility is small; (2) absorption is preferred when acetylene make is high, when it has least ethylene value, and when the production rates are very high. M. F. M.

MISCELLANEOUS

1824. Nuclear radiation finds new horizons in process instrumentation. E. J. Freeh. *Petrol. Engr*, April 1959, **31** (4), C10.—Nuclear radiation can be applied in the process industries for measurement of: (1) composition of binary mixtures and pseudo-binaries; (2) % solids in a slurry; (3) vapour/liq ratio; (4) interface detections (pipeline and process equipment); (5) chromatograph detector; (6) chemical reaction monitoring; (7) density and level.

Three characteristic types of radiation are emitted by radioisotopes, namely, α, β, and γ. α and β radiation is corpuscular and particulate, whereas γ radiation is electromagnetic with an extremely short wavelength and high energy. Radium is used as a source of α radiation; strontium-90 and krypton-85 as β sources, and radium, caesium-139, and cobalt-60 as γ emitters. The details of how various types of radiation interact with matter are quite involved, and a short attempt has been made in the paper to describe the phenomena. Measurements of density for stream analysis, the % of solids in a slurry, and level measurements are treated in more detail. Description and sketches of the type of equipment used are also given. M. F. M.

1825. Oil and politics in Brazil, Colombia, and Venezuela. Anon. *Petrol. Times*, 11.9.59, **63**, 560.—The two goals of the Brazilian state oil corporation are building up of refinery capacity to domestic self sufficiency and provision from

domestic sources of 45–50% of crude throughput by 1961. In Brazil some 40% of the 60 million inhabitants live in urban surroundings and half the country is owned by 2% of the population.

In Colombia coffee provides 75% of export earnings and oil most of remainder. Development of oil industry has been slow because of high costs involved; a large number of wildcats had to be drilled to locate existing oilfields, and reserves proved small. *Ca* 50% of Colombia's production is exported as crude, remainder locally refined.

In Venezuela, in spite of attempts to secure larger revenues, total government receipts in 1958 actually fell, partly due to decrease in output and partly to world economic stagnation.

Julia is Venezuela's largest oil producing state (which includes Lake Maracaibo). Recent tendency is for a larger proportion of country's output to be refined locally.

As for import and export of petroleum equipment, Venezuela does not restrict import of drilling equipment except for few items locally manufactured, but it is common for Latin countries to impose import restrictions due to lack of foreign exchange. G. A. C.

1826. Ain Dar gas-injection project. J. W. Barker. *Petrol. Engr*, April 1959, **31** (4), B36.—Arabian-American Oil Co is investing $30,000,000 in a project which will gather and inject 200 million cu ft of gas/day in the Ghawar fields in Saudi Arabia. This is to conserve the natural resources and to maintain reservoir pressures in the Ain Dar area. The piping system consists of 22-, 24-, 26-, and 30-inch gathering lines with a total length of 34 miles. All compressors in the injection plant are centrifugal with five stages of compression. Each compressor is driven by a separate gas turbine rated at 8000 hp. Max compression pressure in the plant is set at 2100 p.s.i.g. The injection plant, including the generating facilities, will cost $17,000,000 and the gas gathering lines, separator plants, etc., $13,000,000. M. F. M.

1827. Microwave system broadens scope. K. P. Ray. *Petrol. Engr*, 1959, **31** (4), D27.—This paper gives a detailed account of General Electric Co's new microwave system consisting of a 2000-mc Quadriphase line with a 6700-mc Type UA.6 to accommodate either frequency division or time division multiplexing, or a combination of the two. The equipment is basically a vacuum tube design. Transistors have been used in proved circuits of optional accessories where their use offered definite advantage. The unit employs low power, conservatively rated reflex klystrons which have a life expectancy of the order of 20,000 hr. A block diagram of the UA.6 system is shown in the paper, and a full description is given of the modulation amplifier, RF head assembly, automatic frequency control, baseband amplifier, diversity control unit, and the transfer and recording unit. M. F. M.

1828. Underwater television—new tool for pipeliners. E. H. Truex. *Petrol. Engr*, April 1959, **31** (4), D44.—Underwater TV, first successfully used at the Bikini atom bomb trials, affords a comparatively new and potentially valuable aid in determining the condition of underwater pipelines and platforms. It can also be used to determine the location of pipelines and to see that they are not laid over underwater obstructions.

The underwater closed circuit television system is composed of three components: camera, camera control unit, and the TV monitor. The system operates on 110 v, 60 cycles and requires 500 W. Any number of monitors may be fed from one camera, and built-in connectors provide for radio intercommunication between the camera and camera control. The camera is mounted in housing that can withstand water pressures to depths greater than 1000 ft.

Some dramatic events in which underwater TV has been used during the past few years are reported in the paper. M. F. M.

1829. Ravenna—state-controlled petrochemical industry. (In German.) J. Ashton. *Chem. Ind.*, 1959, **11**, 398.—The Italian chemical industry is making greater use of petroleum and natural gas as a raw material. In a general review particular reference is made to the project at Ravenna. P. J. K.

1830. Beginning of petrochemicals in Latin America. (In German.) G. Banaskiwitz. *Chem. Ind.*, 1959, **11**, 395–7.—A review of the development of a petrochemical industry in S America, with particular reference to developments in Brazil. Projects in Venezuela, Colombia, Peru, Chile, and Argentina are mentioned. P. J. K.

1831. The concentration of sulphur dioxide in the atmosphere near power stations. W. G. Cummings and M. W. Redfearn. *J. Inst. Fuel*, Aug 1959, **32**, 358–63.—The Central Electricity Research Laboratories portable sulphur dioxide meter has been used to measure the concn of SO_2 in the atmosphere near 11 power stations with stacks varying from 180 to 450 ft. It was found that in every case the concn of SO_2 at ground level was low and max concn were not greater than 30 parts of SO_2 in 100 million parts of air in normal weather. D. K.

1832. Weather observations in the Persian Gulf. T. F. Gaskell and D. L. Hibbert. *Petrol. Times*, 11.9.59, **63**, 556.—To replace local superstition about local weather conditions in the Gulf and add to the forecasts provided by the RAF synoptic meteorology from its few stations and by port authorities, the oil companies have added reporting facilities, and thus a fairly detailed cover for the whole of the Persian Gulf has been achieved. All stations are fully equipped for sending in reports, and almost all have anemographs for making continuous records in wind speed and direction.

The Weather Reporting Oil Company Stations are linked up with local government meteorological services.

Their usefulness is of great benefit in knowledge requirement of largest waves and max wind force likely to occur in the design stages of drilling platform construction. This provision of weather observations is of fundamental importance for offshore drilling, and also for planning small boat and helicopter movements, prospecting, diving, and tanker loading.

The article describes in general the weather in the Persian Gulf and emphasizes the difficulty of forecasting the "shamal."

It was the loss of the Shell platform off the Qatar coast in a sudden storm in Dec 1956 which brought home the necessity for some form of meteorological service.

A map is given showing the weather reporting network. G. A. C.

1833. Systems engineering. T. J. Williams. *Oil Gas J.*, 10.8.59, **57** (33), 93.—It is predicted that the next ten years will see solution of most of problems in use of systems engineering and computer application, as much instrumentation and automatic control, including computer control, as can be economically justified being employed. Eight refs. G. A. C.

1834. Partial enthalpy charts for light hydrocarbons. A. J. Gully. *Petrol. Engr*, July 1959, **31** (7), C3.—The partial enthalpy data used are derived from the Benedict–Rubin–Webb equation of state, and are believed to be the most reliable presently available. Partial enthalpy charts for methane, ethane, propane, *iso*butane, and normal butane in hydrocarbon mixtures are given for a pressure of 468 psia, with a datum of the pure component in the ideal gas state at 0° R. Some examples of calculations based on the charts are given. G. D. F.

1835. What to do about salt water. (The Atlantic Lectures of the University of Texas. Pt 9.) H. Lewelling and M. Kaplan. *Petrol. Engr*, July 1959, **31** (7), B19.—The characteristics of

oilfield brines are given, and the possible methods of disposal are discussed, *e.g.* evaporation, pumping to sea, underground injection. A number of problems in the disposal of such brines, and possible methods of preventing these are listed, *e.g.* scale formation, corrosion, emulsion formation, microbial action. The economics of brine disposal are discussed briefly. Some current development work on chemical treatment, control of scale deposition, corrosion inhibitors, de-ionization, etc., is also mentioned. G. D. F.

1836. Legal systems governing oil exploration and development in foreign countries. W. A. Sackmann. *Petrol. Engr*, June 1959, **31** (6), B117.—The fundamental differences of legal systems based on Common Law and Civil Law are discussed, and the basic concepts are divided into four systems. (1) The U.S. and Canadian system: a system of leases is in use, the lease lasting until production ceases. Surface and subsoil rights are usually separated. (2) Nationalistic system (Mexico, Iron-Curtain countries, etc.): a government agency is in charge of all petroleum operations. Foreign exploration is discouraged. Spain, France, Iran, etc., pursue a policy lying between systems (1) and (2). (3) Negotiated Concession system (Venezuela, most of Middle East): all conditions of operation are settled in advance, and must be re-negotiated on expiry of the concession. (4) System controlled by mining or petroleum laws (most S American countries): the state retains ownership, but grants exploitation concessions. The petroleum laws vary quite widely from country to country. Important examples are discussed. G. D. F.

1837. Sahara petroleum. L. Fava. *Chim. et Industr.*, 1959, **82**, 135–41.—Illustr account. Reserves (tons $\times 10^6$) Hassi-Messaoud 500 (d 0·805, S 0·15%, gas 200 m³/ton), Edjeleh 35 (0·850), Zarzaitine 75, Tiguentourine 15 (0·770), Hassi-R-Mel (gas) 10^{12} m³ (d_{air} 0·775, CHG 150 g/m³). V. B.

1838. Motor oils decide octane needs, too. M. L. Kalinowski, L. D. La Croix, and R. A. Nejdl. *Petrol. Refin.*, April 1959, **38** (4), 153.—ON required by an engine is governed not only by C.R. but also by the deposits formed in the combustion chambers. Deposits are derived from motor oils as well as from gasolines, and therefore the composition of the motor oil is intimately tied to octane requirements.

The difference between the poorest choice of oil additives and the best can be an octane bonus of six units. Phosphorus in motor oils reduces surface ignition, and therefore should reduce the ON needed to suppress it. Other inorganic elements which can reduce surface ignition are barium, calcium, and zinc. M. F. M.

1839. Applied hydrocarbon thermodynamics. Pt 10A. Charts for making compressor calculations. W. C. Edmister. *Petrol. Refin.*, April 1959, **38** (4), 161.—Compressor design includes calculations of: (1) temp rise of the gas; (2) the work of compression; and (3) the compressor size. Exponents defining temp and vol changes with pressure are useful in making these calculations for both centrifugal and reciprocating compressors. Charts given in this paper are useful in making such calculations, especially for reciprocating compressors.

M. F. M.

BOOK REVIEWS

The American Petroleum Industry, 1859–1899, The Age of Illumination. Harold F. Williamson and Arnold R. Daum. Evanston, Illinois: Northwestern University Press, 1959. Pp xvi + 864. 87.50.

This book, the first of two volumes commissioned by the American Petroleum Institute to commemorate the centenary of our industry, is the work of a research team headed by Professor Williamson, a member of the Department of Economics at Northwestern University, and Dr Daum, who has had wide experience in the petroleum industry and who for several years worked for the API. They were assisted by a Petroleum History Committee appointed by the API and many individuals from the industry interested in its history.

This first volume carries the story from the days of Colonel Edwin L. Drake through the kerosine age into the beginnings of the gasoline age. Hence, it tells us of the days when the impact of the American petroleum industry was yet hardly felt outside the U.S.A. except in the lamp-oil field and when the struggle against the domination of John D. Rockefeller's Standard Oil Company was being fought. Therefore the authors have divided the history of the industry before 1900 as follows. "Part 1 traces the continued interest in petroleum from antiquity to its early medicinal use in North America. Part 2 indicates the background and the events which, by the 1850's, had brought revolutionary changes in the domestic supply and uses of artificial illuminants, notably lard oil, camphene, manufactured gas, and coal oil. These changes in turn provided a rich technological and marketing heritage for the infant petroleum industry. In addition to the familiar account of Drake's discovery, Part 3 describes the contribution of less-publicized pioneers who did much between 1859 and 1861 to provide the foundations for a permanent industry. Part 4, covering the years 1862–1872, carries the story of petroleum through its formative years which, against a background of intensive competition, saw an impressive growth in crude supplies, transport and processing facilities, and the development of foreign and domestic markets. Following an examination in Part 5 of the conditions that prompted Rockefeller and his associates to develop their plan to dominate the refining and transportation segments of the industry, the chapters in Part 6 analyse the successful execution of this plan, which by the mid-1880's had completely changed the competitive structure of the industry. Part 7 completes the history of American petroleum to 1900. It was during these years that production of crude was extended beyond the Appalachian fields into Ohio–Indiana, and American independents were able to grow despite Standard's general success in expanding and integrating its operations into marketing and production. It was also during this period that the American industry was faced with increasingly intensive competition in foreign markets from Russian and Dutch East Indian interests."

This summary of the contents in the authors' own words give a fair picture of the contents of this volume, which can, of course, hardly be discussed here in detail. One can only say that the subject, on which much research was spent, is discussed in as fair and impartial a way as possible. One might, perhaps, suggest that too little attention was given to European literature of the period, but this would not, I believe, add materially to the evidence presented here. Nearly 150 maps, diagrams, and photographs, many of which are presented here for the first time, enliven the text, which is written in a fluent style and is very readable. Nearly 60 pages of references point the reader to the most important documents on the history of our industry, and a

six-page epilogue and summary forms the introduction to the second volume.

Six appendixes covering some 32 pages give a very valuable amount of statistical data, which are mostly difficult to obtain from other sources. They conclude a volume which is worthy of the centenary of Drake and should be read by all who are interested in the growth of our industry and who wish to understand the trends and currents of the past. The volume is well produced and certainly worth its relatively low price. We look forward to the publication of the second volume. R. J. F.

Liquid–Liquid Extraction. L. Alders. Amsterdam: Elsevier Publishing Company; London: D. Van Nostrand Co. Ltd, Second Edition, 1959. Pp. xiii + 209. 32*s*.

Solvent extraction has been a well-established process in the petroleum industry for many years. In fact, the Edeleanu process for refining kerosine was first used in Rumania exactly 50 years ago. It has been followed by processes for refining lubricating oils and for obtaining concentrates of the lower boiling aromatics, benzene, toluene, and the xylenes. Although many articles on solvent extraction have been published in the technical journals, it is perhaps surprising that until recently few books had appeared on the subject.

The appearance in 1955 of Mr Alders' book was therefore of considerable interest, particularly as the book was aimed at giving detailed knowledge of the theory of liquid–liquid extraction and its application in industrial laboratories. The book describes essentially the experimental technique for obtaining the data required for extraction calculations, the methods of calculation, and the laboratory operations which may give information relating to the performance of commercial extraction processes. Although the text was open to criticism on the grounds of various omissions, the first edition could be recommended to industrial chemists as a good introductory text.

In the second edition the scope of the book is essentially the same, but Mr Alders has undertaken a considerable amount of re-writing which has resulted in improved phraseology and clearer figures and tables. It is satisfactory to see that more extensive references to the literature are now included in the text.

The first chapter is concerned with phase equilibria in ternary systems and the graphical presentation on a ternary diagram, while in the second chapter methods of determining the equilibria in such systems are fully described with the aid of numerical examples. In the present edition there is more information on methods available for the interpolation of tie lines.

In the third chapter cross-current extraction, *i.e.* successive treatments of a raffinate with fresh solvent, is described and the economic disadvantages of this method of extraction, a small yield of raffinate and a large solvent requirement, are clearly stated. On the other hand, the advantages of single-solvent counter-current extraction are described in Chapter IV, which has undergone considerable revision in the second edition. Maloney and Schubert's constructional method for determining the number of extraction stages has now been added to the description of Hunter and Nash's method. A warning is also given of the danger of regarding a multi-component mixture, *e.g.* a petroleum cut, as a binary mixture when one is calculating by the Hunter and Nash method the number of stages required to extract a petroleum cut.

The author describes in the present edition a new method which he has developed for calculating the solvent treatment in multi-stage counter-current extraction which is claimed to be more reliable than the constructional methods. An improved mathematical treatment is also given of the effect, encountered in industrial extraction processes, of recycling recovered solvent which is contaminated with a small quantity of feedstock.

In the two following chapters the author's new method of calculating the solvent treatment and number of stages are also applied to two-solvent counter-current extraction and to the use of reflux in extraction processes. Various aspects of two-solvent counter-current extraction are described in considerable detail, and it is interesting to see that consideration has been given to light–heavy selectivity, a problem which is to be borne in mind when the extraction of a multi-component mixture, *e.g.* a petroleum cut, is under examination. Chapter V also contains, for the first time, a discussion of the Craig distribution method.

It is considered that this book will be of great value to the petroleum technologist who wishes to obtain general information on solvent extraction processes or who, on the other hand, is required to evaluate an extraction process, as he will find that most aspects of the extraction of petroleum fractions have been considered. J. A. E. M.

Analysis of Pipe Structures for Flexibility. John Gascoyne. London: Sir Isaac Pitman & Sons Ltd, 1959. Pp. xiii + 181. 45*s*.

This book has been written to meet the needs of piping designers and draughtsmen and perhaps to stimulate their interest to acquire further special knowledge of piping stress analysis.

It describes an elastic-centre method of stress calculation and includes two examples of two-anchor problems completely calculated on this method.

Other subjects covered are various designs of expansion joints, pipe supports, and a method for the determination of support loadings. A chapter is devoted to the various codes and standards used in piping design, and useful appendixes are included giving permissible allowable stresses, thermal properties of piping materials with combined expansion and elasticity factors, and ratios of "hot" and "cold" moduli of elasticity, based on the American Code of Pressure Piping, 1955. These appendixes may, however, require some revision, as there is already a 1959 edition for one of these sections. This is doubtless a matter which will be taken care of by the author in subsequent publications.

As this book is intended primarily for piping designers and draughtsmen, and not the piping analyst, it is felt that the author could have usefully covered such matters as a comparison between good and bad piping design, avoidance of complex systems which defy accurate computation, limitations of expansion joints, and the care with which they must be installed. Some reference to the special treatment of large diameter pipes under high temperature and high vacuum could have been usefully included in the book.

So long as the piping designer and draughtsman treats this book as an introduction to stress analysis it will be a valuable aid to his work. G. E. W.

Modern Road Emulsions. Third Edition. Ed. Technical Committee of Road Emulsion Association Ltd. London: Road Emulsion Association, 1958. Pp. xiii + 180. 21*s*.

In the early 1930's the Road Emulsion Association organized a series of lectures for highway engineers on the properties and manufacture of bituminous emulsions. The first edition of "Modern Road Emulsions," published in 1933, was based on these lectures with some additional material and the third edition now issued preserves the character of the original lectures. The book is primarily written for the civil engineer rather than the chemist, and the assumption is that the reader is familiar with road surfacing processes but not with colloidal chemistry.

Following brief historical surveys of road surfacing and bitumen manufacturing procedures, successive chapters discuss: (1) the physical chemistry of emulsions; (2) their manufacture; (3) their general characteristics; and (4) the mechanism of break of emulsions on the road. The main value of the book lies in these chapters, which are both very complete and are written in commendably simple and unambiguous language. The main changes in the new edition are the revision and expansion of the chapter on physical chemistry and the inclusion of a two-page discussion on cationic emulsions in the chapter on manufacture.

The section dealing with the use of emulsions in various road applications has been revised and brought up to date.

The book embodies the considerable experience of members of the Technical Committee of the Road Emulsion Association, and they and their Chairman, E. R. Hatt, are to be congratulated on their revision of this useful work.

A criticism on a point of detail is that the chapter on bitumen manufacture might with advantage recognize the long-established practice of the use of semi-blowing processes for the preparation of emulsion grades of bitumen.

P. J. N.

Elimination of Oxides of Nitrogen from Automobile Exhaust. Francis R. Taylor. Air Pollution Foundation Technical Report 28. San Marino, California: The Foundation, 1959. Pp. 49. $2.00.

This report covers an investigation to determine the possibility of removing nitrogen oxide from automobile exhaust by catalytic reduction with carbon monoxide or carbon monoxide and hydrogen from gases present in the exhaust. It was previously shown that nitrogen oxides play a vital role in smog-producing reactions, and in Los Angeles, for example, it is estimated that 65–85 per cent of these oxides result from burning gasoline in automobiles, the remainder originating from gas and fuel burning.

The present report demonstrates the feasibility of reducing nitrogen oxide by carbon monoxide and/or hydrogen in the presence of catalysts such as zinc–copper chromite, iron chromite, barium-promoted copper chromite, and chromium-promoted iron oxide. It is also shown that not only can nitrogen oxide be eliminated with iron oxide, but also hydrocarbons and carbon monoxide, provided sufficient oxygen is supplied to the exhaust stream.